ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. LI. No. 8. NEW YORK, SATURDAY, AUGUST 24, 1907. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WILLIAM HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

NEW YORK
PUBLISHING OFFICE . . . . . 13-21 PARK ROW
CHICAGO
WESTERN OFFICE . . . . . MANHATTAN BUILDING
BOSTON
NEW ENGLAND OFFICE . . . . . 95 MILK STREET
LONDON
EUROPEAN OFFICE, HENRY W. HALL, Manager, 42 OLD BROAD STREET, E. C.

TELEPHONE AND CABLE

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States $3.00
One Year, Canada 4.00
One Year, Foreign Countries 6.00
Single Copy, 10 cents. Back numbers, beyond one month, each . . .25

ADVERTISING

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

Published weekly by the ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York. Charles W. Price, president and treasurer; Stephen H. Goddard, secretary.

Entered at the Post Office at New York as second-class matter under the Act of March 3, 1879.

CONTENTS

EDITORIAL:
- Electric Culture 277
- Electrical Power in Mexico 278
- Early Lessons of Electrical Engineering 278
- The Failure of the New York Municipal Electric Lighting Plant 279

Electric Culture 280
New York City Loses Paving Suits 280
French Electrical Exhibition 280
Long Acre Company Lets Contract 280
The Use of the Synchronous Motor as a Phase-Compensator, by R. E. Hellmund. 281
Street Railways Here and Abroad 283
Wire-Testing, by L. M. Jones 283
The Cost of Metal-Filament Lamps 284
The Park Royal Power System and the Hammersmith Electric Railroad 285
Boiler, Engine and Generator Testing and Management—VI. by Charles L. Hubbard 292
American Electrochemical Society 293
The British Association, by Silvanus P. Thompson 294
The Rubber Industry of Singapore 297
Allis-Chalmers Machinery Used in Coal and Coke Operations, by W. B. Spellmire. 298
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE 300
INDUSTRIAL SECTION:
- National Alternating-Current-Direct-Current Air-Brake Apparatus 302
- Cutler-Hammer Lifting Magnets 304

Wireless Telegraph Advance 305
The Westinghouse Officials 305
Centennial of Fulton's First Steamboat 305
CURRENT ELECTRICAL NEWS 306
RECORD OF ELECTRICAL PATENTS 311

Copyright, 1907, by Electrical Review Publishing Co.

ELECTRIC CULTURE.

At a recent meeting of the Royal Botanic Society, of London, Mr. B. H. Thwaite presented a paper describing the experimental installation which he has carried out at the Royal Botanic Gardens, in Regent's Park, in that city, for studying the effects of electrical stimulation upon plants. An abstract of this paper is given on another page of this issue. Mr. Thwaite has certainly gone about the matter in a way which may be expected to give more definite results than any of the scattered and ill-directed attempts which have been made from time to time. The object of this installation was apparently to see to what extent artificial means can increase the productiveness of plants, and the attempt is to be made on an engineering basis—that is to say, the results must be obtained by the use of power, which in this case is to be got from coal. The combustion of the coal furnishes heat, which drives a gas engine, the latter driving a dynamo, which furnishes electrical energy for artificial illumination, and, by means of a static machine, high-tension discharges for stimulating the leaves and roots. The waste heat from the engine is to be utilized in controlling the temperature in the experimental house, while the waste gases after purification will supply the carbon dioxide and nitrogen needed for plant food. Thus the temperature, the food, the lighting and the stimulation of the plant will be under control. Only in this way can the effect of any one or any combination of these conditions be determined.

Mr. Thwaite has, however, set himself a difficult task, as there are no less than six conditions to be controlled and varied—the temperature, moisture, illumination, electrical stimulation, and the quantities of carbon dioxide and nitrogen—and in order to determine the effect of any one of these, the others must not only be held constant at different points, but the conditions which they introduce must be known—that is to say, an increase in the intensity of illumination may be beneficial, provided there is an ample food supply or the temperature is just right; while a change in either of these latter conditions might cause increased illumination to be detrimental. It will probably be some time before the real scientific facts are learned, but the problem is being attacked in the right way. Whether or not there will be any commercial value in the results thus secured remains to be seen. If certain fruits can be produced at unusual times, or the quality greatly improved, it might be found that practical application on a large scale would pay. It is rather interesting to note that it has been the custom to heat plant houses for forcing purposes, and that in the method described by Mr. Thwaite all the energy obtained from the fuel is eventu-

ally converted into heat, the lighting and electrical stimulation being intermediate processes. An exception, possibly, should be made here to those small portions of the light energy and electrical discharges—if such there be—which are taken up directly by the plant without being converted into heat. Thus, it would seem that if it be desired to maintain a certain temperature no additional energy may be required to control the other conditions, provided, of course, the fuel necessary to heat the house is sufficient to supply the necessary light by means of the gas engine, as seems probable.

ELECTRIC POWER IN MEXICO.

An important field of electrical development is said, in a recent issue of the *Engineering and Mining Journal,* to be in the application of electric power to the mining industry of Mexico. In that country the deposits of minerals are rich, and already a great deal has been done to develop them, but this work has been hampered by the lack of cheap power. The climate is good and labor is abundant and cheap, so that all that is necessary to bring the mining industry rapidly to the front is a cheap supply of power. This power can be secured by developing the waterfalls, and except for the inaccessibility of much of the mining country, there should be no great difficulty in doing this. There are already some noteworthy hydro-electric systems in Mexico, but it is probable that much of the work in connection with the mines will be done on a smaller scale.

For mining purposes electric power seems to be ideal, for it furnishes at the same time not only safe, convenient illumination, but supplies as well as the power for hoisting, for traction purposes, ventilating, and operating all the machinery used in connection with the work of the mine. In Mexico it will supply a definite need, and its application will probably be rapid. The effect will, no doubt, be that which has followed its use elsewhere—a notable increase in the output of the establishment.

There are many who cling to old methods of driving machinery, because they are familiar with them and sometimes because they compare the cost of running machinery by the present method and that which they estimate it would be if the motor were installed. However, the gains made in other directions by the use of electric power are so great that an increase in the cost of power, even if it be considerable, becomes of minor importance. Often there is an important gain made by improving the method of illumination, as the cost of lighting the shop is a small matter compared with the loss due to bad lighting. Yet these features, which are so easily secured by means of the electrical system of power distribution, are ignored, and older engineers will not turn to them until they are driven by some necessity, such as that which will probably lead to a wide use of electric power in the Mexican mines, and make these an important factor in the industrial world.

EARLY LESSONS OF ELECTRICAL ENGINEERING.

Those who are fortunate enough to take up the study of electrical science at the present time frequently do not realize the difficulties which the fathers of that science encountered. At the time that it was shown possible to produce mechanical motion by means of a device drawing energy from a galvanic cell, the suggestion was naturally made that there might be some useful adaptation of the new power; but this was before the invention of the dynamo, and it was soon seen that no primary cell could compete with the steam engine of those days, crude though it were as compared with the engine of to-day, because of the cheapness of coal as compared with zinc and sulphuric acid. In those days the reversibility of electrical apparatus was not recognized; in fact, some of the more fundamental physical laws had not at that time been clearly enunciated, and difficulties presented themselves which now are never thought of, because the student of to-day is taught these principles and sees evidence of them on all sides. Even when the principle of magnetic induction had been discovered it was many years before it was realized that that method of construction which produced the best generator was most suitable for the construction of motors. This conclusion was reached after years of painful effort, and apparently was not hastened by the statement of an early worker that a rotary motor or one in which there were no reciprocating parts was far better mechanically than the old electric engines—devices patterned after the steam engine. We are wont to look back upon the thirty years following Faraday's great discovery as years of slow progress, but when it is considered that it was during these years that some of the great principles which govern our work to-day were enunciated; that it was at that time that the foundations for electrical science and practice were being laid, a better appreciation of the work of the fathers is gained.

Another of the principles equally as important as the reversibility of electrical apparatus is that special application of Lentz's law applied to electric motors. Action sets up a reaction, which opposes the original action; otherwise there would be a cumulative effect. In a motor the windings on the armature, due to their rotary motion in the magnetic field, generate an electromotive force which opposes the current which turns the armature. In other words, the armature of an electric machine acts as a dynamo armature, irrespective of whether the machine be driven by mechanical power or by electrical power exerted through the same winding. This is one of the puzzling facts to the beginner and is one of the stumbling blocks which the first builders of electric motors came across. They found that a motor, when running, would take less current than would flow through the armature if it were still. This was thought to be a great disadvantage, because it was supposed to limit the power of the machine. Efforts were made to design motors without this drawback. The student to-day is shown not only that this counter electromotive force is unavoidable, but that it is actually necessary;

for a motor without a counter electromotive force would not run. To do work a force must overcome a resistance, and in this case the applied electromotive force overcomes the opposing electrical force in order to be converted into mechanical effort. That portion used up in overcoming the resistance of the armature is lost, since this determines the amount of heat developed by the passage of the current; therefore, the higher the counter electromotive force, the higher the efficiency or the greater the proportion of electrical energy converted into mechanical energy. Hence the aim to-day is to design a motor with low resistance and a high counter electromotive force.

Another retarding influence which affected considerably the development of the electric motor was due to a misinterpretation of the law defined by Joule. He showed that the maximum possible rate of working of any motor is when it is working at an efficiency of fifty per cent. This law is true, but it was not realized that the law followed by the electric motor is not the same as that governing the performance of a steam engine. The losses in a motor are not constant, hence the efficiency does not continue to rise until the motor is stalled. Early engineers thought, however, that Joule's law stated not merely the maximum performance of the motor, but the maximum efficiency as well, and that therefore no motor could have an efficiency above fifty per cent. Until this misinterpretation was corrected the electric motor was looked upon as a toy or as a device of no practical utility. Joule's law is still true, but to-day it is properly understood, and does not even affect the work of the designer, as there are few motors of the constant-speed type which can withstand a load that reduces their speed to one-half the normal, at which speed the work would be a maximum. The output is now limited by the losses in the machine, and the rate at which the heat thus developed can be dissipated.

There are a number of such laws which lighten the work of the student of to-day and show him the proper direction in which to direct his efforts. If he should go back over the history of electrical applications he would find many instructive lessons, not only in the science, but in the application of electricity. Frequently, old devices are resurrected to accomplish a purpose which improvement had made unnecessary, but which has again become desirable on account of still further change. Such, for example, is the reintroduction of the so-called inter-pole, which was one of the first devices used to assist in commutation. It is regrettable that courses in engineering are so crowded that there is no time available for a satisfactory study of the history both of the science and its application. This would be instructive and interesting; it would explain many things that to some remain confused often until after they have completed their work at the college. To-day the history of the science is generally hurriedly given, and only that part which has led to the immediately important results. Frequently the study of failures is as important and instructive as that of successes, particularly when these failures can be viewed in the light of later knowledge. For these reasons every student of electrical engineering owes it to himself to supplement his work in the class room, which is necessarily limited by lack of time, by a review of the long and often painful development of his science and profession.

THE FAILURE OF THE NEW YORK MUNICIPAL ELECTRIC LIGHTING PLANT.

The recent announcement that the city of New York intended abandoning the electric lighting plant which it has been operating for lighting the Williamsburg bridge has led to a good many comments upon this as an instance of another example of the failure of municipal plants. But it should not be overlooked that this was not a lighting plant pure and simple, but was operated in connection with a refuse destructor, and we in this country have not as yet had much experience with destructor plants. There were too many elements involved here. There was the operation of the destructor itself, the running of the electric lighting plant, and the relations between these two. Very few engineers would to-day recommend the use of refuse for fuel if this were the only end sought, but since refuse must be got rid of some way or other, it is a question of hauling it away or of burning it; and which of these be the cheaper will depend upon local conditions. Probably some years hence the value of city refuse will be better appreciated, or means will be developed for enabling this to be turned into profit, but at the present time destructor plants are operated at an expense. Some steam can, of course, be raised in these destructors, and this should be utilized, if practicable; but it happens that refuse is a very bad fuel for supplying steam to a variable load. Destructors are at their best when operated continuously, and can not be forced economically. Electric lighting, however, is required only during a part of the twenty-four hours, and it does not furnish an altogether satisfactory load for a destructor plant.

So far as the New York lighting plant itself is concerned, it is a fact that the city engineers estimated that the light thus secured was costing the city more than it would have to pay if the light were furnished by the local company. It does not appear that any particularly inefficient methods were found, although it is probable that this plant was not free from those disadvantages which we have been accustomed to associating with municipal undertakings. As long as this plant was in operation, those who believed that the city should furnish the lighting of its streets pointed to it as an example of successful municipal control. Its failure, however, may have been due to the more or less complicated situation, and does not seem to warrant any conclusions other than that this particular arrangement was not successful. Nevertheless, the fact remains that it has not been found profitable to light the Williamsburg bridge from this municipal plant, and the municipalizers thus lose one of their shining examples.

Electric Culture.

At a recent meeting of the Royal Botanic Society in London, B. H. Thwaite described the experimental work which is being planned for the Royal Botanic Gardens in London. He said that if an imitation of natural forces is to be secured by the artificial cultivation of plants independently of the sun or weather, the following agents must be assembled and harnessed for the common object: There must be an ample supply of violet or chemically active rays projected from powerful arc lamps. There must be a supply of electrostatic current for atmospheric and root electrification. The plant must be surrounded by an atmosphere containing moisture and carbon dioxide in the proportions common to the most fertile countries and at temperatures within the limits of seventy and eighty degrees Fahrenheit. There must be an ideal fertilizing agent and an ample supply of water for the roots.

The system of electric culture about to be put to a practical test is designed to produce the conditions specified on a large scale. The necessary heat and actinic light, as well as the carbon dioxide and moisture and nitrogen fertilizer in the form of ammonium sulphate, are to be derived from coal. A suction gas-producer plant is to be installed, supplying gas to a gas engine, thus producing perfect combustion simultaneously with the development of power. The latter is to be converted into electrical energy. The heat developed during the production of the gas and the operation of the engine is to be absorbed by cooling water and utilized for heating the air in the plant house. The exhaust gases are to be cooled and the heat utilized in the same way, and the coal gases, after being purified, are to be carried into the house so as to supply the required carbon dioxide, water vapor and nitrogen. The author estimates that the heat energy of the coal will be divided as follows: thirty per cent for power production; thirty per cent for jacket water, and thirty per cent for waste gases, ten per cent being lost in radiation. The gases are to be desulphurized both before and after combustion. The electrical energy is to be used for operating the arc lamps, and an electrostatic machine is to be driven by the engine for supplying static discharges for stimulating the roots and leaves of the plant. The arc lamps are to be equipped with special reflector hoods confining the beam within narrow limits of concentration. The end of the hood will be enclosed by a water jacket, so as to secure as nearly as possible an imitation of the natural solar effects and to limit the effect of the ultra-violet rays. The nitrous oxide gases produced by the arc are to be carried off.

The installation will permit a wide range of experiments to be made, with a view to determining the conditions necessary to secure a maximum degree of acceleration of plant growth and the most perfect quality, and augmentation of waste products. The power of producing fruit at any period of the year was successfully attained by Sir William Siemens with a comparatively primitive installation, and a triple combination of water-screen arc lamp, electrostatic stimulus and highly fertilizing atmosphere will, it is believed, secure still better results.

New York City Loses Paving Suits.

The attempt by the city of New York to force the street railway companies to pay the cost of repaving the portions of streets between the tracks is not likely to be successful if a report which has been filed with the Supreme Court by Hamilton Odell, as referee, is confirmed.

The report refers to only four suits out of thirty-five or more brought by the city, but an agreement was reached between the corporation counsel and the railroad lawyers by which the final decision in the cases before Mr. Odell is to be considered binding and conclusive in all the other suits.

The four suits before Referee Odell involved a total claim of $211,000 by the city on the Broadway & Seventh Avenue, the Metropolitan, the Ninth Avenue and the Bleecker Street and Fulton Ferry railroad companies. The dispute over the cost of repaving the streets between the tracks has been going on for about fifteen years and culminated in 1903, when the suits were begun. Michael H. Cardozo was first named as referee, and on his death Mr. Odell was appointed to continue the taking of testimony and report his findings.

Mr. Odell finds that there is nothing in the franchises which would compel the defendant companies to pay the cost of repaving, nor does the street railroad act of 1884, in which such a provision occurs, apply to the defendants, since they were not incorporated under that act.

Furthermore, Mr. Odell says, the city had no right to enter upon the tracks and repave the street in between without giving reasonable notice or making a demand upon the defendant corporations. The absence of any proof that such notice was given as required by the law passed in 1890 with reference to repaving debars the city from any recovery. Judgment is therefore ordered for the defendant companies.

It is said that the repaving between the tracks has cost the city several million dollars in the last fifteen or twenty years. None of this money will be recoverable should Mr. Odell's opinion be reaffirmed on appeal.

French Electrical Exhibition.

Consul John C. Covert advises that a circular has just been issued announcing that the Agricultural, Scientific and Industrial Society of Lyon will hold its second Exposition of Electrical Appliances for Agriculture, Art and Industry in that French city in May, 1908, details of which follow:

The circular states that the water power of the various mountains in France, the Dauphine, the coast of the Mediterranean, the basin of the Loire, the Eastern Pyrenees and Auvergne offers over 300,000 horse-power, all tributary to Lyon and all in the neighborhood of a rich agricultural country. The aim of the promoters of the exposition is to discover means of making this immense reserve power accessible for daily use on farms and in the various industries in the cities and villages of all the Midi or south of France, nearly half of the national territory. A smiliar exposition held in May, 1906, displayed many new electrical exhibits, principally made by Frenchmen.

Long Acre Company Lets Contract.

It is announced that the Long Acre Electric Light and Power Company has placed a contract involving $10,000,000 for the construction and equipment of two electric generating plants with the American and British Manufacturing Company, Providence, R. I. In order to secure the funds needed to pay for this contract the Long Acre Company has authorized a bond issue amounting to $10,000,000 of general mortgage five per cent bonds. The two stations will be of 50,000 horse-power each. One of these plants will be used to supply customers in Harlem, and the other to furnish light, heat and power to customers in Long Acre Square and other down-town districts of New York city.

THE USE OF THE SYNCHRONOUS MOTOR AS PHASE-COMPENSATOR.

BY R. E. HELLMUND.

The possibility of running a synchronous motor with leading current naturally suggests the use, where possible, of such motors on lines which supply a large inductive load, in order to compensate for the wattless currents thus caused. There is no doubt such an arrangement is advantageous when the power station is at one end of a long line, while the energy consumers are at the other end.

Consider now the case (Case I*a*), in which a power of 1,000 kilowatts is to be transmitted a distance of about five miles. The nature of the power consumers may be such that 500 kilowatts is taken by a large synchronous motor, while the rest of the power is supplied to induction motors. The combined effect of the induction motors and their transformers may be such, that a lagging current with a power-factor of 70.7 per cent results. In order to reduce the line current to a minimum the synchronous motor will have to be operated with a leading current of the same power-factor if it is direct-connected to the line. The rating of the synchronous motor required is then approximately given by the load it will carry divided by the power-factor and will therefore be $\frac{500}{.707} = 707$ kilovolt-amperes.

The capacity of the alternators at the power-station should be

$$\frac{1,000}{.80 \times .90} = 1,390 \text{ kilovolt-amperes}$$

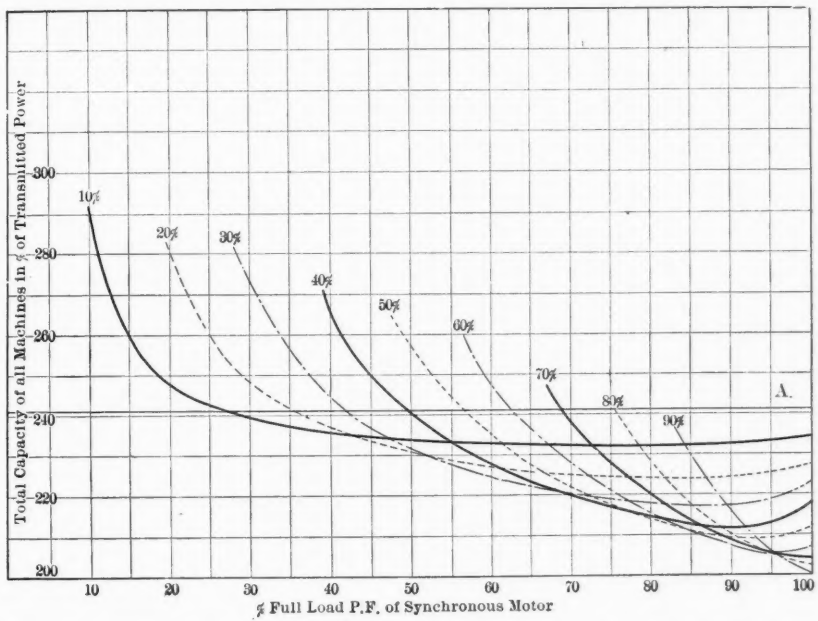
if the efficiency of the consuming plant is assumed to be eighty per cent and that of the line ninety per cent. If under these assumptions the potential at the consuming plant is 6,000 volts, the wire required for the transmission line will be 0 B. & S. and its weight will be 25,000 pounds.

The main parts of the transmission system will have the following ratings:

Generators.....1,390 kilovolt-amperes.
Synchronous motor.... 707 kilovolt-amperes.
Induction motors..... 500 kilowatts.

Total.....2,597 kilowatts in machine investment.
Total amount of line copper.....25,000 pounds.

This is assuming that the size and cost of the induction motors is about proportional to their output in kilowatts, which is approximately the case.



RELATION OF CAPACITY OF SYNCHRONOUS MOTORS TO PERCENTAGE FUEL-LOAD POWER-FACTOR.

Consider now the case (Case I*b*), in which the same power is to be transmitted but that all power is used by induction motors, and that the induction motors have an average power-factor of 70.7 per cent. The rating of the alternator should then be $\frac{1,000}{.80 \times .90 \times .707} =$ 1,965 kilovolt-amperes, the same efficiencies as before being assumed. The wire required for the transmission is now No. 00 B. & S., and its weight will be 33,000 pounds. The main parts of the transmission system will be:

Generators .....1,965 kilovolt-amperes.
Induction motors.....1,000 kilowatts.

Total capacity.....2,965 kilowatt in machine investment.
Total amount of line copper.....33,000 pounds.

If we compare this with Case I*a*, we find that, assuming the same efficiencies, we may save 2,965 — 2,597 = 368 kilowatts in machine investment, and 33,000 — 25,000 = 8,000 pounds of copper by means of the synchronous motor.

The amount of capital investment that may be saved in this way by the use of synchronous motors, has caused a number of engineers to assume that the use of synchronous motors is advantageous in all cases and to choose them so that their use is not at all advantageous, or only so in a limited way.

Consider, for instance, a case (Case II*a*) in which again 1,000 kilowatts must be transmitted as before, but where only 100 kilowatts of the load are suitable to be driven by a synchronous motor, while the remaining 900 kilowatts must be induction-motor load. If other conditions are as before, the total induction-motor current will be

$$\frac{900}{.80 \times .707 \times 6,000 \times 1.73} = 153 \text{ amperes}$$

and the wattless current will be 108 amperes.

The watt current of the synchronous motor will be

$$\frac{100}{.80 \times 6,000 \times 1.73} = 12 \text{ amperes.}$$

If now the synchronous motor is, as frequently done, designed to take care of the total wattless current of the induction-motor load its total current will have to be

$$\sqrt{12^2 + 108^2} = 114 \text{ amperes,}$$

and it will run with a power-factor of

$$\frac{12}{114} = .105.$$

Its rating will therefore have to be

$$\frac{100}{.105} = .955.$$

The generator will have to have a capacity of 1,390 kilovolt-amperes, as in Case I*a*, and the weight of the transmission copper will also be the same.

The main parts of the transmission system will be:

Generators .....1,390 kilovolt-amperes.
Synchronous motor..... 955 kilovolt-amperes.
Induction motors..... 900 kilovolt-amperes.

Total.....3,245 kilowatts in machine investment.
Total amount of line copper.....25,000 pounds.

Now compare this with Case I*b*, in which no synchronous motors have been used, we see that although 8,000 pounds of line copper may be saved by the use of the synchronous motor, this apparent advantage must be paid for with an additional machine investment of 3,245 — 2,965 = 280 kilowatts, and it is obvious

that in this case the installment of the synchronous motor is hardly advisable. .

Some advantage might be secured for Case II*b* by using a synchronous motor if the power-factor be about 70.7. Such a motor would compensate a wattless current of

$$\sqrt{\left(\frac{.707}{12}\right)^2} - 12^2 = 12 \text{ amperes.}$$

Then the line would have to carry 108 + 12 = 120 amperes watt current and 108 — 12 = 96 amperes wattless current and 153 amperes total current.

The wire required for the line would be No. 00 B. & S. and its weight 33,000 pounds. The capacity of the alternator should be

153 × 6,600 × 1.73 = 1,750 kilovolt-amperes

and that of the synchronous motor

$$\frac{100}{.707} = 142 \text{ kilovolt-amperes.}$$

The main parts of the transmission system will therefore be:

Generators	1,750 kilovolt-amperes.
Synchronous motor	142 kilovolt-amperes.
Induction motors	900 kilovolt-amperes.
Total	2,792 kilowatts in machine investment.
Total amount of line copper	30,000 pounds.

If this be compared with Case I*b*, it is seen that 2,965 — 2,792 = 173 kilowatts in machine investment have been saved by the use of the synchronous motor running with 70.7 power-factor.

This Case II*b* shows that some advantage may be secured by using synchronous motors, even if the load which can be taken care of by the motors is only a small percentage of the total load, but that it is necessary to consider the conditions carefully in order to make the right choice of the synchronous motor and that it is not always advantageous fully to compensate the wattless current in the line and generators.

The question then is for what full-load power-factor should the synchronous motor and the alternator be installed in each particular case, in order to obtain a minimum cost for a certain condition. It is obvious that conditions in practice change too much to make it possible to give a general rule. However, in the following it is endeavored to discuss a series of cases covering the condition which occur most frequently in practice and from which it will be possible to draw some general conclusions. In all the instances given, it will be assumed that the power-factor for the inductive load is 70.7, this being a value which represents a fair average for plants with induction motors, and being at the same time convenient for calculation, since it gives watt current and wattless current of equal amplitude. The curves in Fig. 1 give the total machine ratings which are required in per cent of the power to be transmitted as a function of the full-load power-factor, for which the synchronous motor is chosen. The curve for ten per cent, for instance, gives these values under the assumption that ten per cent of the total load may be taken by synchronous motors; the curve marked twenty per cent is calculated under the assumption that twenty per cent of the total load may be synchronous motor-load, etc. The straight line A gives the total required machine capacity under the assumption that only induction motors are used. It will be noticed that all curves given reach a minimum value of the total machine capacity for a certain power-factor of the synchronous motor. This value, however, is not necessarily the point for which the minimum capital investment may be obtained. It may be that the nature of the transmission is such that the generators run with a much lower speed than the motors and that therefore the price per unit of generator-capacity is much higher than that of the motors, and *vice versa*. Of course if this is the case it should be taken into consideration. Besides this the cost of the line copper and that of the transformers, if such are used between the generator and synchronous motors, should be taken into consideration. This can be done in a comparatively simple way. We know that the weight and cost of the line copper is proportional to the generator capacity; the same is true in regard to the transformers at the generator station and all other transformers which are used for the inductive load and the synchronous motors at the same time. If a transformer be used for the synchronous motor only, its capacity and cost are proportional to the size of the synchronous motor. We may therefore make distinction between a group (A) of apparatus and materials, the cost of which is proportional to the output of the generators in kilovolt-amperes, and another group (B) of apparatus, the cost of which is proportional to the full-load output of the synchronous motor divided by the full-load power-factor of the same. In any problem of the kind under consideration, the first thing to do is to find out approximately the total cost of the apparatus in group A per kilovolt-ampere of generator output, and the total cost of the apparatus in group B per kilowatt output of the synchronous motor divided by its power-factor. This is comparatively simple, since the approximate size and the speed of the machines is mostly given from the beginning. After this the following coefficient may be found:

$$C = \frac{\text{Cost of group A per unit}}{\text{Cost of group B per unit}}$$

The following table will give approximately the most favorable values of full-load power-factor for which the synchronous motor should be chosen:

Synchron. Motor Load in % of Total.	Coefficient C.						
	2	1.75	1.5	1.25	1	.75	.50
10	.30	.40	.60	.65	.75	.80	.90
20	.50	.60	.65	.80	.90	.90	.90
30	.70	.70	.80	.90	.90	.90	.90
40	.90	.90	.90	.90	.90	.95	.95
50	.90	.90	.90	.90	.90	.95	1
60	.90	.90	.90	.95	.95	1	1
70	.95	.95	.95	.95	1	1	1
80	1	1	1	1	1	1	1
90	1	1	1	1	1	1	1
100	1	1	1	1	1	1	1

In using this table it will be well to keep in mind that the choice of a power-factor slightly differing from those given in the table does not change the cost of the plant much. This may be seen from Fig. 1, which not only gives the machine capacities, but also the cost for C = 1. It will be seen that all the curves are very flat near the minimum value. If, therefore, special reasons arise which make it desirable to have the generators as large as possible this may be done without much additional expense by choosing the synchronous motor power-factor somewhat lower as given in the table and *vice versa*.

After the power-factor for the synchronous motor has been chosen the exact capacity and cost of the various parts may easily be determined. Then, as a rule, it is advisable to figure also the cost of the plant under the assumption that induction motors are used in place of the synchronous motor. In a good many cases, especially where the capacity of the synchronous motor can be only a small percentage of the total capacity of the plant, it will be seen but little can be saved by the use of the synchronous motor, especially if the more expensive starting devices required are taken into consideration. Even though a small amount may be saved by using synchronous motors in many cases it is not advisable to use them if the much simpler and safer way of starting and operating induction motors be given the consideration it deserves.

In some cases the use of a synchronous motor may be advantageous for the opera-

tion of the system on account of its tendency to improve the potential regulation. If, for instance, a sudden increase of the inductive load decreases the potential of the alternator the synchronous motor will draw automatically a larger wattless current, which has a tendency to increase the alternator potential. The drop of the alternator will therefore be smaller than it would if no synchronous motor were on the line. In the same way a synchronous motor counteracts a rise of potential. As another advantage of the synchronous motor may be mentioned its constant speed feature, which, however, is of practical value only in certain cases.

Of course the exactness of the conclusions drawn from the above considerations may be largely effected by special conditions, but for ordinary situations they will give quickly a general idea of what machines should be chosen.

Street Railways Here and Abroad.

The Wall Street Journal has abstracted some interesting figures from the reports of the committee which recently made investigation of the public utilities in this country and in the United Kingdom of the effect of municipal ownership concerning street railways in the two countries.

The average receipts per passenger in the United Kingdom was 2.26 cents, as against 3.76 cents in the United States. However, 9.65 passengers rode per car mile there, as compared with 5.2 passengers here. The increase in passengers carried between 1890 and 1902 in Great Britain was 868,083,625. In the United States the corresponding increase was 3,598,499,318.

British Street Railways, 1905.

	Population Served	Miles of Track	Population Per Mile
Greater London	6,581,000	274.68	23,958
Glasgow	1,000,000	147.62	6,779
Manchester	850,000	146.19	5,130
Liverpool	798,000	104.00	7,663
Birmingham	650,000	44.50	14,606
Leeds	450,142	89.07	6,765
Sheffield	432,940	65.83	6,577
Patteriles Dist.	400,000	38.43	10,409

American Street Railways, 1902.

	Population Served	Miles of Track	Population Per Mile
New York	3,716,169	1,349	2,754
Chicago	1,873,820	925	2,026
Philadelphia	1,367,716	540	2,533
St. Louis	612,279	345	1,775
Boston	594,618	253	2,073
Baltimore	531,313	228	2,330
Cleveland	414,950	182	2,280
Buffalo	381,403	198	1,926
San Francisco	355,919	283	1,257
Pittsburg	345,045	176	1,960

In Great Britain, naturally, the greatest density of population is found in London, where the inhabitants are 23,958 per mile of track. Second to London is West Ham, with 17,616. In the United States the city with the biggest population per mile is Jersey City, with 3,658. There are nineteen cities in Great Britain with a higher rate than this.

WIRE-TESTING.[1]

BY L. M. JONES.

In the successful operation of a telegraph system carrying, as most systems do, a volume of business almost equal to the capacity of the facilities under favorable conditions, it is of the utmost importance that all the wires available be kept in use as nearly all of the time as possible.

To do this, some one must be made responsible for all delays in locating and removing trouble, which can best be done by the division of the territory into wire-testing districts.

The proper location of the wire-testing offices is very important, as there are usually many things to be taken into consideration. Almost invariably there exists on every wire-testing district a necessity for repeaters or quadruplex apparatus, and in order to have these located under the direct supervision of the wire chiefs, the office is located where the repeaters and multiplex apparatus are required.

In order to secure the best results, the hours of duty should not be such as to overtax the physical ability of the wire chief. The twenty-four hours may best be divided into three tricks of eight hours each, corresponding with those worked by train dispatchers. The first trick, 8 A. M. to 4 P. M., can be taken care of by the manager of the office, with the dual title of wire chief and manager; the second trick, 4 P. M. to midnight, and the third trick from midnight to 8 A. M.

The wire chief and his assistants, to be successful, must, in addition to having had experience in wire-testing, be fully posted in the handling of multiplex apparatus.

One thing very essential to the successful wire chief is patience. Few operators at way offices understand thoroughly their switchboards and circuits even when regular, consequently when asked to make a patch, they lack confidence in their own ability, and should the wire chief lose patience, the result will probably be a wrong connection, and the loss of much valuable time.

Each wire-testing office should be supplied with, in addition to a spring-jack switchboard and spare sets at the board for testing purposes, a milammeter and voltmeter of suitable scale ranges.

In the location and clearing of trouble, the methods in use are much the same everywhere; however, it may be well to enumerate separately those which are usually followed, and from which satisfactory results are obtained.

FOR A GROUND.

The margin or pull of the relay magnet will give a good idea as to whether the wire is grounded near at hand; then proceed by having offices open the wires until the ground is located between two offices.

FOR AN OPEN CIRCUIT.

If the circuit is a comparatively long one, and paralleled by other working circuits, place the voltmeter in the circuit for a moment. If near at hand, the needle will remain almost stationary; if very unsteady, the open is probably some distance away. Or, place the open wire on a battery of preferably more than 100 cells, then cut in a test set and let the relay spring down low, opening and closing the key. If the break is comparatively close, a very short dot will follow the opening and closing of the key; if further away, the dot will become perceptibly plainer, increasing with the distance from the test office to the open. A large number of relays in the circuit, however, will detract from the sensitiveness of this latter test. This will save time in tracing for the location. Have different offices ground the wire until located in an office, or between two offices. If the wire is broken between offices, one end will usually touch the ground and remain grounded, while the other will remain open. This, if known, will give a good idea as to the location outside of an office. However, the usual office tests should be made.

FOR A CROSS.

When two or more wires are crossed, have the distant terminal open all wires affected except the most important wire affected. Then locate by having different offices open one or more of the wires which are out. When located between offices, have the usual office tests made to be sure it is outside.

FOR AN ESCAPE.

An escape may be either an escape to a ground, or to another wire. An escape to a ground is located in the same manner as a ground. An escape to a cross is located the same as a cross. If only slight, it may only be felt with a voltmeter, and resemble closely poor insulation.

OFFICE TESTS.

In testing for trouble in an office, first have the wire cut out at the bottom of the board, removing the instrument plugs. This will clear the wire if trouble is not in the board. If this does not clear it, have the wires removed from the top of

[1] Assistant superintendent of telegraph, Santa Fé Railroad. Read before the convention of the Association of Railway Telegraph Superintendents, Atlantic City, N. J., June 19-21.

the board, and the ends twisted together. This will clear if in an office. The same test at the other of the two offices between which the trouble was located will definitely locate it outside of an office.

To clear a switchboard of a burned lightning arrester, remove the grounded wire temporarily until the plate can be removed and filed or scraped, and insulated with mica. If an office has hinge or gate cut-outs instead of a switchboard, the wire should first be cut out, then if the trouble does not disappear, the removal of the ground wire from the cut-out will have the same effect as taking the wires out of the top of the switchboard. A plug cut-out or one-wire board should be handled in the same manner as a switchboard.

Wire chiefs often complain of failure of operators to follow instructions, especially when requested to remove wires from the top of switchboards and cut-outs. This is sometimes due to the fact that linemen have used pliers to tighten nuts, and the operator not having a pair, is unable to take the wires out, and rather than tell the wire chief he can not do so, makes a bluff by waiting a sufficient length of time and probably saying "Now," leading the wire chief to believe the wires have been removed.

In order that a lineman may not be given a wrong location, for example, the day chief locates trouble on his district, which, the lineman being at some distant point, and train service such as to make it impossible to reach the trouble before dark, instead of notifying him at once, transfers the trouble to the second trick chief; he retests and transfers to the third trick chief, who retests and notifies the lineman. In this way no time is lost in clearing the trouble, and the lineman is not disturbed in case the wire comes clear in the meantime. If an interruption is reported to a lineman by the first or second trick chief, and he fails to clear the trouble before dark, he reports this to the wire chief on duty. The wire should then be retested and the lineman advised if still in, or of any new developments.

All wires should be tested by the third trick chief before daylight. Linemen understand if no trouble is reported to them, none exists, leaving them free to carry out any projected work on hand.

The train wire is of first importance, and must be made good, if needs be, at the expense of everything else. The through quadruplex wires are of next importance. After locating and patching trouble out of a circuit, the patched circuit should not be again disturbed until it is known that the trouble has been removed. However, the section where trouble exists must be watched closely and tested frequently without waiting for the lineman to call for a test. In testing, the through circuit should be left intact, and the section where the trouble existed tested by using a local circuit.

When cleared, and circuits are regular again if a quad wire, the offices having the quad sets should be notified at once in order that a new balance may be taken, if necessary. The taking out of fifty or seventy-five miles of iron wire from a copper circuit often working on a very narrow margin may so affect the balance as to make the wire almost unworkable.

In order that there may be no delay in clearing wire trouble, it is necessary for the wire chief to at all times know the exact location of his division line repairer. Early each morning, say 7 A. M., each line repairer should file a work report giving movements for the day, stating explicitly just where he will be, and on what trains he will move, if away from headquarters, advising the wire chief immediately of any change in his plans.

In case of unusual conditions prevailing, wire chiefs should be authorized to direct the movement of construction or repair gangs, as communication with the superintendent's office may be entirely cut off by wire trouble at any time.

In case of a sleet storm, or any unusual interruption affecting all wires, so as to cut off communication with the general office, each wire chief should immediately advise his superintendent fully of the conditions on his own district, and continue to do so at intervals until communication is again restored, using Western Union or Postal wires, if working. If all commercial wires are down, the telephone toll lines should be used, if available.

GENERAL REMARKS.

I have noticed a tendency on the part of some wire chiefs to discourage operators calling for a balance, which often results in operators working for some time on a wire almost unworkable, which could be remedied by a balance, and its capacity often doubled.

The third trick chief should, in addition to testing all wires early in the morning, carefully inspect his repeaters and quadruplex apparatus, especially the points of his pole changers and transmitters, and balance his quadruplex sets, for the reason that during the early hours of the morning possibly only one or two corners have been in service, and the wires are too busy to be taken out of service for this purpose after the arrival of the first trick chief. While the use of files for cleaning points is very necessary at times, it should be borne in mind that a clean, smooth point is by far more desirable than a clean, rough one, or one with sharp edges or corners.

Once a week, all wires should be measured for insulation, and current strength of different circuits measured. Quad batteries should also be measured, compensating resistances of quadruplex sets adjusted, and a full report mailed to the superintendent of telegraph. For insulation tests, a battery of approximately 100 cells should be used, all wires to be removed from this battery while being used for this purpose. The wires should be removed for the reason that otherwise the current strength will vary, being governed by the demands upon the battery, due to the opening and closing of the other wires.

In making insulation tests we use a battery of 100 cells if available, or a current of ninety volts potential, inserting a voltmeter in the different circuits, having the distant terminal open the wire, noting and recording its deflections. If the needle shows an escape, intermediate offices are called in until the point of escape is located as nearly as possible. The lineman is then advised and instructed to report when covered. Upon receiving his report, the wire is again tested and the lineman advised of the result.

The current readings are taken by inserting a milammeter in the different circuits while conditions are as nearly normal as possible. In this way we secure a report showing the actual amount of current being furnished for the operation of each wire.

The Cost of Metal-Filament Lamps.

In a letter to the *Electrical Engineer*, London, the General Electric Company, Limited, of Great Britain, gives the following selling prices for the Osram lamp, for which it is the British agent. This is one form of the tungsten lamp. The prices given are for retail, no allowance being made for discounts to the trade. For lamps rated at thirty candle-power the price is $1 each; fifty candle-power, $1.06; 100 candle-power, $1.62. The efficiency of these lamps is said to be 1.1 watts per Hefner candle-power, which is equivalent to 1.25 watts per English candle-power.

The Park Royal Power System and the Hammersmith Electric Railroad.

(By Our British Correspondent.)

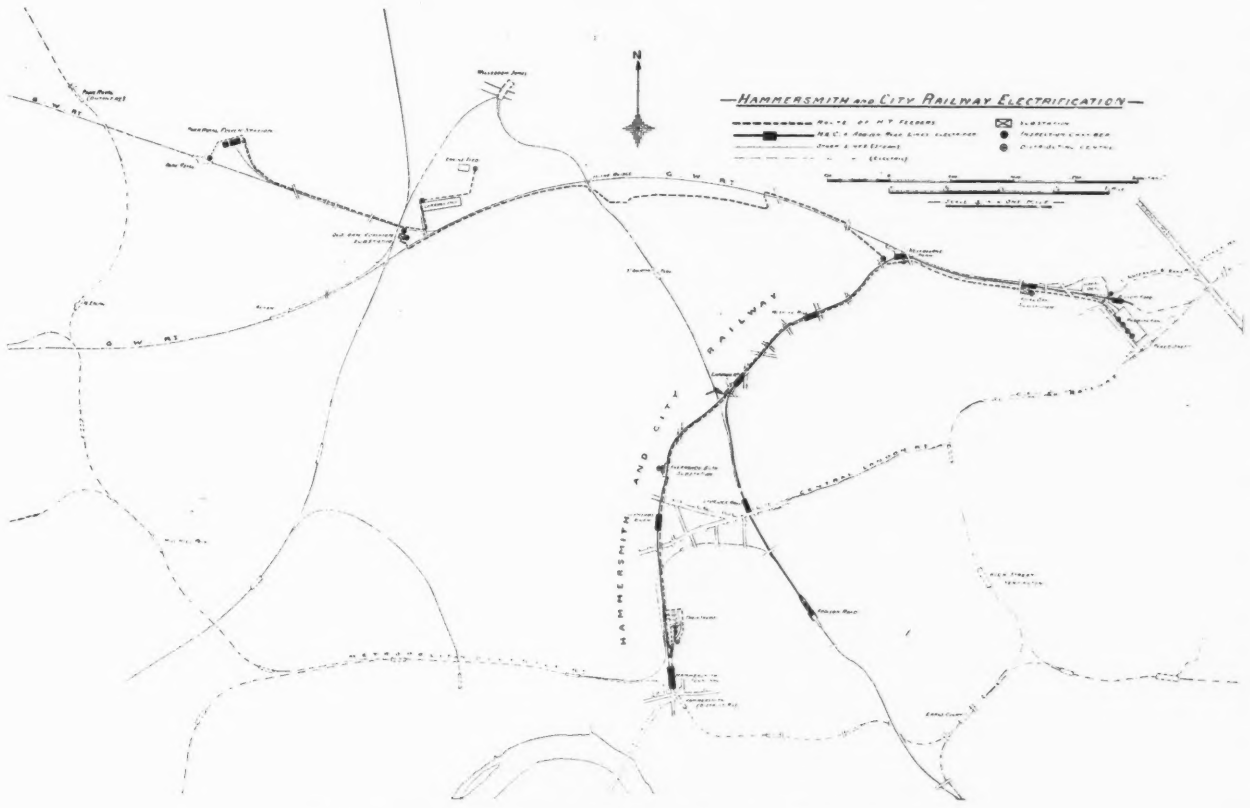
NOW that the network of London tubes has been completed—at any rate for the present—practically the only electric railway construction work that is in actual progress in the metropolitan area is the equipping of the London & Brighton Company's single-phase sections. The next will be the Euston to Watford undertaking of the London & North Western. For the moment there is little news beyond that concerning the controversies of experts as to the respective merits of different systems. In the country the position is the same, the only work of moment being the single-phase equipping of the Morecambe-Heysham section of the Midland Railway.

Apart from the tube undertakings the most recent London electric railway traction system is that of the Great Western Railway, with which is necessarily coupled the Hammersmith and City line and some other tracks to which reference will be made later. We are now enabled by courtesy of Messrs. Kennedy & Jenkin, the consulting engineers, and with the assistance of the photographic department of the Great Western Railway, to present the following illustrated description of this undertaking to readers of the ELECTRICAL REVIEW.

The new power system of the Great Western Railway has been installed for a variety of purposes, including the electrical working of part of the Metropolitan Inner Circle Railway, the Hammersmith & City line, and also the lines of the Great Western Company used in connection with the Hammersmith & City Railway. The extent of the lines is shown on the accompanying map.

It includes the Hammersmith & City line proper, with its branch line from Latimer Road to Uxbridge Road, and the Great Western additional lines between Bishop's Road and Westbourne Park. For some distance the trains run over the West London line, and a portion of that has therefore had to be electrified. The system of supply to trains had to be the same as that in use on trains running over the Metropolitan lines on the Inner Circle. From the power station current is supplied for arc and incandescent lighting and small motor work throughout the Great Western system in the London district, as well as on the Hammersmith & City Railway.

In connection with the main generating station there are three substations and eleven distributing centres.



HAMMERSMITH & CITY RAILWAY (LONDON, ENGLAND) ELECTRIFICATION.

At the station which is situated at Park Royal three-phase alternating current (6,300 to 6,600 volts, fifty periods) is generated, and it is transmitted to three substations, in which the greater part of the three-phase current is converted by motor converters from about 6,500 volts alternating to 600 volts direct current, and at this pressure supply is made to the conductor rails of the Hammersmith & City and other lines worked in connection with it from Royal Oak and Shepherd's Bush substations. From Old Oak Common, Shepherd's Bush and Royal Oak

substations, direct current is distributed at 600 volts for sundry power purposes and for arc lighting, to locomotive sheds, etc.

A certain part of the three-phase supply is distributed from each substation at the full pressure of about 6,500 volts to the distributing centres, where it is transformed down by static transformers to either 220 or 110 volts, for considerable arc and incandescent lighting and small motor work.

The present station is so designed and placed as to enable five other similar stations to be built when required. At the extreme east end are the coal silos, built below ground level so as to be underneath the railway siding which connects with

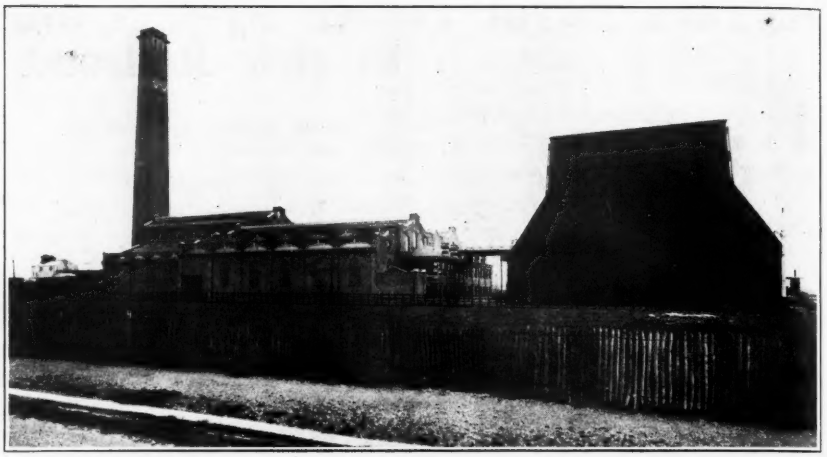
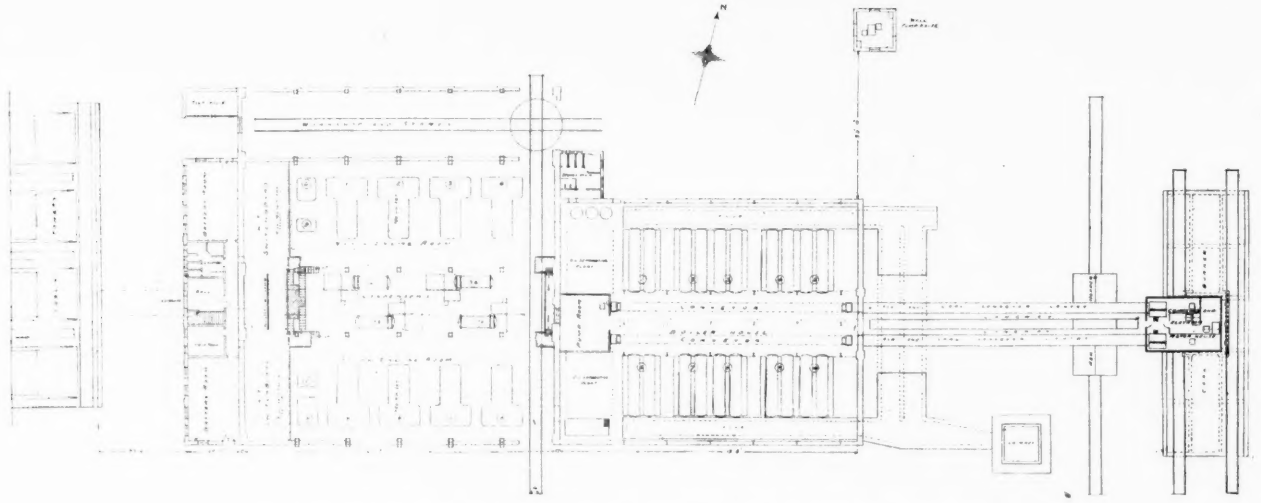


Fig. 1.—General View of Park Royal Generating Station from North Side.



Plan of the Park Royal Plant of the Hammersmith & City Electrification.

the main line. These silos are constructed of ferro-concrete and have a total storing capacity of about 400 tons. They are divided into five funnel-shaped sections, from the mouthpieces at the bottom of which the coal passes into a basement which accommodates the filling apparatus for the coal conveyers.

The boiler house has two side bays for boilers, and a clear centre bay over which a set of steel coal bunkers (600 tons), built between the main stanchions, is provided.

The main engine room is situated to the west of the boiler house. The two side bays accommodate the engine sets, and the centre bay the condensing plant, which is also above floor level. The switchboards are arranged on galleries extending across the whole breadth of the engine room at the west end. Under the offices, and just outside and throughout the length of the west wall of the engine room, a cable tunnel is provided through which the

Fig. 2.—Park Royal Station. Conveyer Driving House and Ash Fillers Over Sidings.

feeder cables are carried after leaving the switchboard basement.

The boilers are of the water-tube type, and the main engines are of the reciprocating, high-speed, triple-expansion type. There are ten Babcock & Wilcox double-drum boilers, each having a heating surface of 5,764 square feet and equipped with a self-contained superheater. They are fitted with chain-grate stokers, each shaft being driven from either end by a fifteen-horse-power three-phase motor. There are four steam-driven feed pumps of the vertical type, while oil-separating and filtering apparatus, Edwards air-pumps and Klein natural-wood cooling towers are installed. In the engine room the steam pipes are on the ring system.

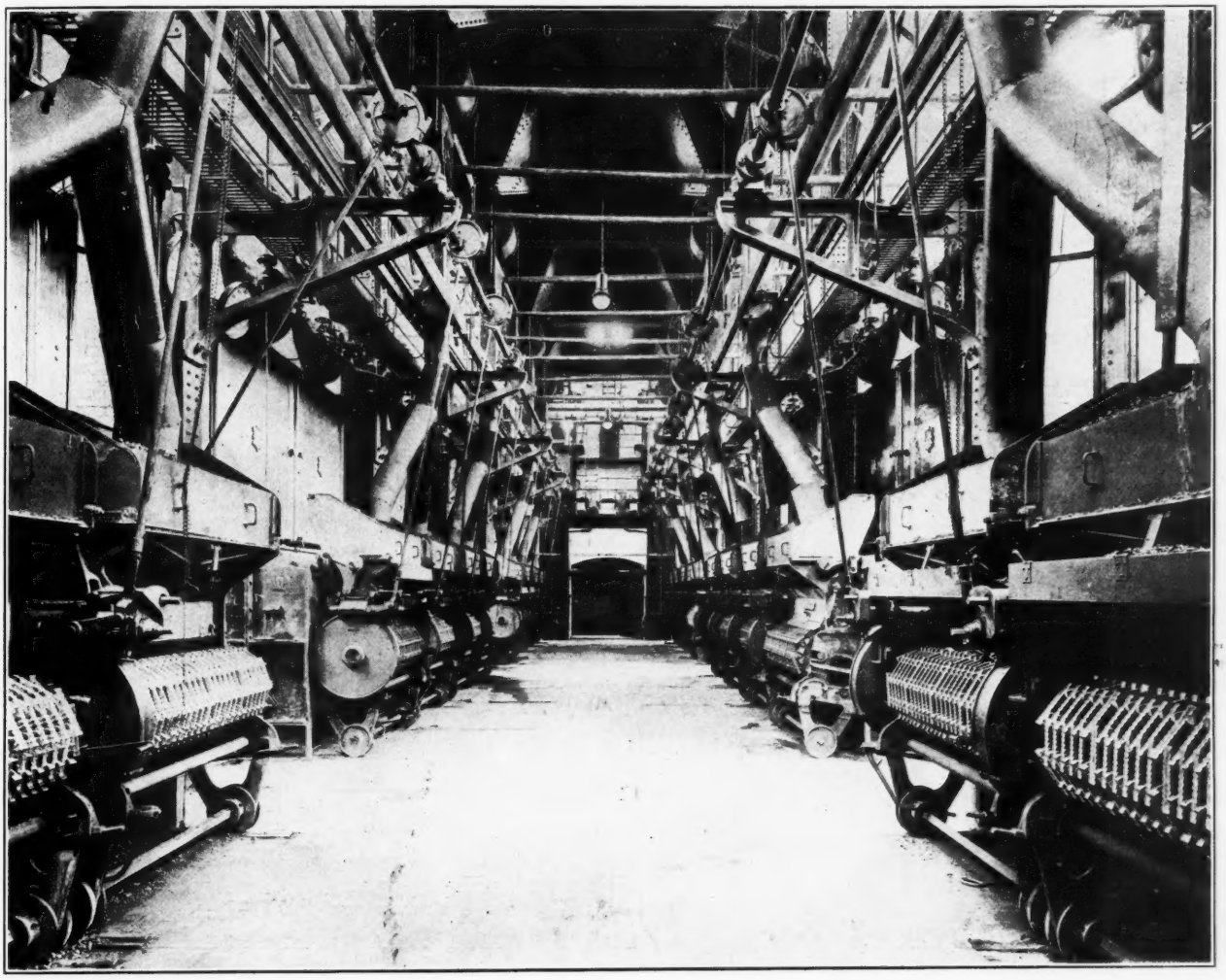


Fig. 3.—Park Royal Station. General View of Boiler House from Stoking Floor.

Each main generating set (there are four in each side bay) consists of a Belliss steam engine driving direct an Electric Construction Company's three-phase generator of 750 kilowatts normal output with a twenty-five per cent overload capacity. The engines are three-crank, triple-expansion, high-speed (250 revolutions), with cylinders eighteen-and-one-half-inch, twenty-seven inch, and forty-inch by eighteen-inch stroke. The governor is controlled by an electric motor, from the main switchboard gallery, for adjusting the speed of the engine during synchronizing, and for adjusting the load between the sets running in parallel. An emergency valve, electrically controlled from the switchboard, is also fitted to each engine. The generators are of the ordinary rotating-field magnet type, the total weight of the magnet wheel and flywheel being about eleven tons. The stationary armature is wound in open slots and is star-connected, but the centre point is not permanently earthed. Screws are provided for sliding the armature sideways for inspection when required.

There are eight 150-kilowatt sections of auxiliary plant, four of which are normally used for supplying direct current at about 225 volts for excitation purposes, and arc and incandescent lighting and for the overhead crane motors, the remaining four sets being normally used for supplying three-phase, 650-volt current, for driving the various three-phase motors throughout the generating station (stokers, coal conveyers and pumps).

The switch gear includes two main high-tension switchboards, for controlling the 6,500-volt three-phase circuits, which are placed one at the west end of each of the main engine room bays; an auxiliary switchboard, for controlling the 650-volt three-phase circuits, placed on the same gallery as the main switchboard control panels, and two switchboards, for controlling the 220-volt direct-current circuits, placed one at the west end of each of the main engine room bays, on the floor level immediately under the front of the main switchboard control gallery.

The high-tension part of each main

high-tension switchboard extends from the basement to a total height of thirty-three feet and consists of a steel framework filled in with stone slabs. Each circuit runs from the bottom to the top of the board, and is separated from the rest by vertical stone partitions. The switches, transformers, etc., on each circuit are further separated from each other by four horizontal partitions which divide the whole structure into a set of fireproof cells.

lating resistance columns, the engine governor and emergency-valve switches, and also a set of signal columns and indicators by which the switchboard attendant can communicate with the drivers of the engines.

The two main high-tension switchboards can be worked independently of each other, or can have their bus-bars connected for working in parallel.

The circuit for each main generator

cores of the cable in the box. Above the phase-changing links a set of disconnecting links is provided which, when open, disconnect the cores of the cable from the switchboard circuit and connect them direct to earth. The links can be locked in the "open" or "earthed" position. On the cable side of these disconnecting links a set of glow tubes is connected to indicate when the cable is alive.

The synchronizing bus-bars are divided

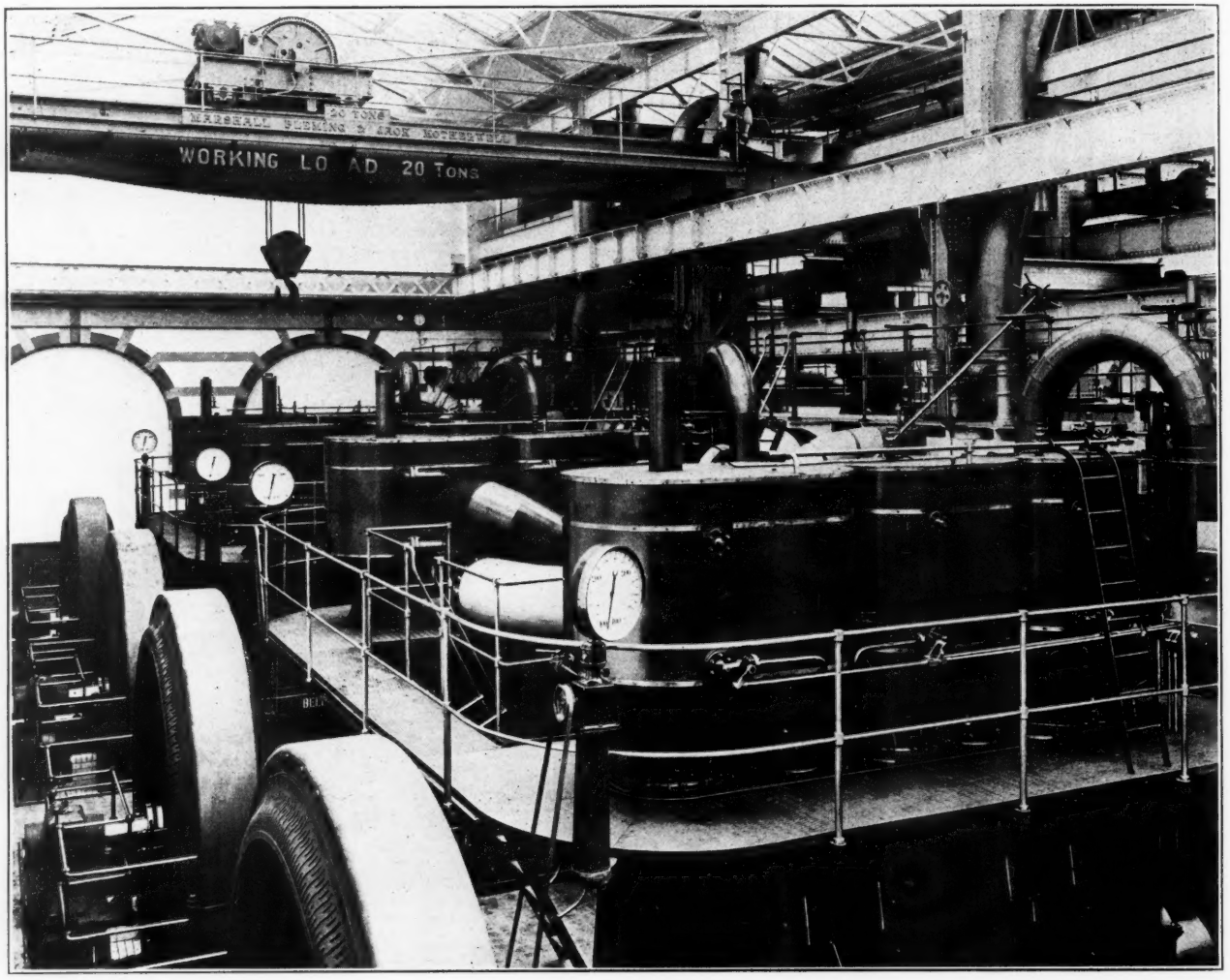


FIG. 4.—MAIN ENGINES FROM SWITCHBOARD GALLERY FROM NORTH BAY.

The control board is placed on a gallery about fourteen feet above the engine-room floor, and slightly in front of the high-tension portion of the switchboard. The main switches are worked from the control panels mechanically by rods and cranks. All the instruments are placed on the control panels and are worked from transformers, so that all connections on these control panels are low-tension. Immediately in front of the control panels are placed the main generator field-regu-

or feeder starts in the basement in a cell which contains the three-core cable sealing and dividing box to which it is connected by three phase-changing links. These links are arranged and shaped so as to enable any core of the cable to be connected to any one of the conductors of the switchboard circuit, in order that the phases of a circuit may at any time be arranged correctly and symmetrically with reference to the phases of other circuits, irrespective of the position of the

into two halves in the centre of each high-tension board, one half being normally used for synchronizing the generator circuits and the other half for charging and testing the feeders. The two halves of the synchronizing bars can be coupled together, and the feeder changing gear can then be connected through the synchronizing bars to any generator which it may be desired to test, or the generator synchronizing gear may be used in connection with the feeders. Each control

switchboard is provided with two sets of synchronizing gear mounted on swing panels at either end of the board. The synchronizers are worked from pressure transformers, one being normally used for the generators and one for the feeders, and each including three lamps, a rotating synchroscope and a pair of paralleling voltmeters. By means of a system of shafting and cams at the back of each control board, a complete mechanical interlock has been provided in connection with the operating mechanism of the high-tension switches.

The auxiliary three-phase switchboard for controlling the 650-volt alternating-current circuits is placed in line with and between the control panels for the two main high-tension switchboards. The auxiliary board is fitted with two sets of bus-bars, which can be coupled together when required. Each of the three-phase

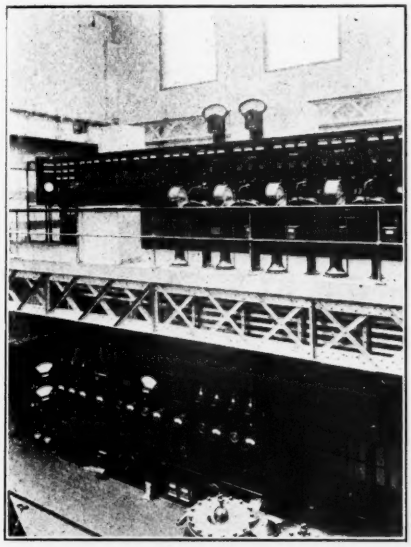


FIG. 5.—PARK ROYAL STATION. GENERAL VIEW OF SOUTH MAIN HIGH-TENSION SWITCHBOARD AND EXCITER BOARD.

650-volt generators and the low-tension side of each set of step-up auxiliary transformers can be connected to either set of bus-bars through one or other set of contacts of a special double switch, which is fitted with an overload release and an interlock between the two sets of contacts.

Synchronizers are provided on swing panels to enable synchronizing to be effected with either set of bus-bars.

The two direct-current 220-volt exciter switchboards can be worked separately or in parallel, and each controls one of the auxiliary direct-current generators, one of the storage batteries, three feeders for working the direct-current crane motors and the arc and incandescent lighting of the power-house, and an excitation circuit for the main and auxiliary three-phase generators. The excitation circuit from each of the direct-current exciter switch-

FIG. 6.—PARK ROYAL STATION. GENERAL VIEW OF MAIN SWITCHBOARD CONTROL GALLERY.

boards is run under the main switchboard control galleries, and the field circuits of each three-phase generator can be connected to either of the two excitation circuits by means of change-over switches with discharge resistances operated from the front of the main switchboard gallery.

In a separate shed outside the engine room two tanks, supplied with circulating water, are provided, each of which forms an artificial load of the capacity corresponding to the output of one of the main generators.

The substation at Royal Oak contains four 400-kilowatt traction motor converter sets, worked in parallel with a battery having a one-hour discharge rate of

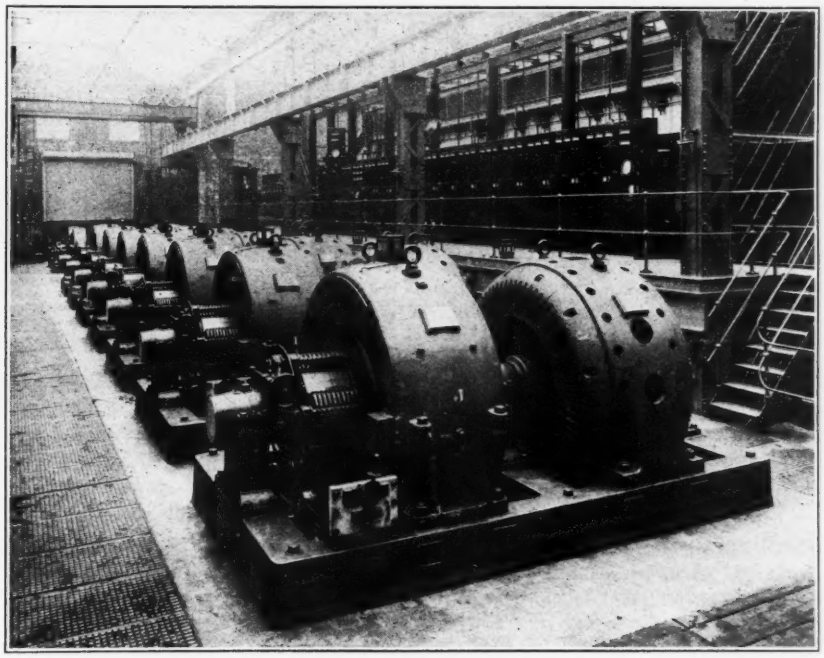


FIG. 7.—SHEPHERD'S BUSH SUBSTATION. MOTOR-CONVERTERS AND HIGH-TENSION SWITCHBOARDS.

1,680 amperes in conjunction with reversible boosters. It also contains two 200-kilowatt motor converters for direct-current lighting and power.

The Shepherd's Bush substation is equipped with seven 400-kilowatt traction motor converters, worked in parallel with a battery having a one-hour discharge rate of 840 amperes, in conjunction with reversible boosters.

The Old Oak Common substation has one 400-kilowatt and two 200-kilowatt motor converter sets for direct-current lighting and power.

From each of these substations high-tension distributor feeders are run from the high-tension bus-bars to the various distributing centres. All three substations are designed so that they may be developed on the same lines. The motor converters are of the Peebles-La Cour type; the reversible boosters are of the Highfield type, and the batteries are of Tudor make. The high-tension switchboards are generally similar in construction and design to those at Park Royal, described in the foregoing pages.

A feature of special interest is the method of using the battery not only to equalize the load on the motor converters, and therefore on the main high-tension generators, by taking the peaks of the traction load, but also, in cases of emergency, for maintaining both the alternating and direct-current lighting supply. The battery is connected through one of the reversible booster sets to the traction board, being connected between the positive bus-bar and the equalizer bar, with the result that the total current returning from the track to the generators and the battery passes through the generator series windings, which are provided with diverter resistances. In the negative bus-bar a main diverter resistance is provided through which the total current returning from the track passes, and the series winding on the booster is connected across a variable proportion of the main diverter resistance. It is arranged so that when the high-tension supply to the substation is interrupted the battery can run the motor converters reversed, taking current on the direct-current side and delivering high-tension alternating current to the high-tension switchboard, from which it is transmitted, as before, to the lighting distributing centres. As soon as the motor converters are reversed from the battery a reverse relay in the positive bus-bar of the traction board operates a change-over switch, which short-circuits the series windings of the generators and alters the connections to the series winding on the booster, so as to produce level compounding with variations of the load instead of over-compounding. In case the traction load be too great to be maintained by the battery under these conditions, it is arranged that a maximum automatic circuit-breaker, connected between the battery and the track feeders, shall open should the current from the battery exceed a predetermined amount. A resistance is connected as a shunt across the terminals of this circuit-breaker, so proportioned that when the circuit-breaker is opened sufficient current can be supplied to the trains to keep the lamps alight until the power for driving the trains can be supplied again. Thus the battery is able to maintain the alternating-current supply to Paddington, the railway stations and other important points until the supply from Park Royal is restored.

A direct connection to the direct-current lighting board also enables the direct-current lighting supply to be maintained from the battery only when required.

In regard to the distributing centres, each of these is a brick chamber, twenty feet by twelve feet by nine feet high. Five of them are placed above ground, four at Paddington station are underground chambers, and two are transformer rooms at substations. Two high-tension distributors are carried from one or other of the substations to each distributing centre. It is arranged that the whole of the distributing centres can be controlled from one or other of the three substations.

Between the generating station, the substations and the distributing centres, about thirty-seven miles of high-tension three-core cable and about fourteen miles

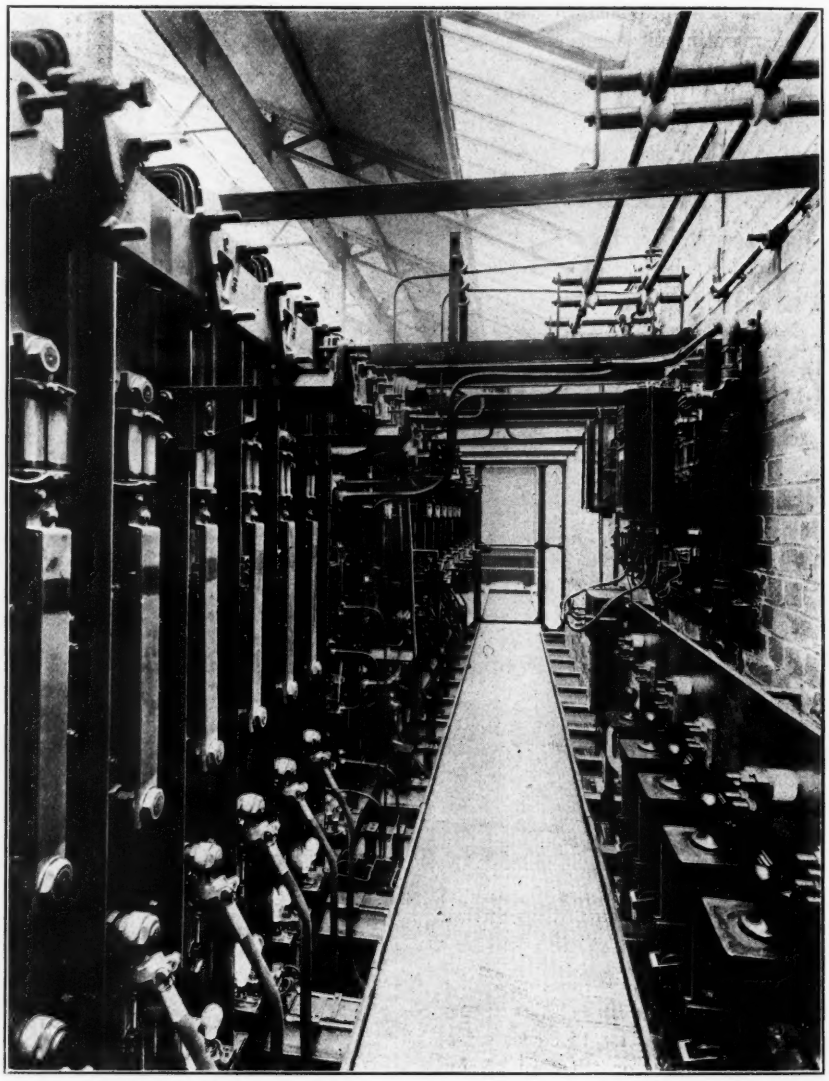


FIG. 8.—SHEPHERD'S BUSH SUBSTATION. BACK OF DIRECT-CURRENT TRACTION SWITCHBOARD.

of low-tension concentric cable have been laid, in addition to three or four miles of single low-tension cable used in the form of jumpers in connection with the conductor rails. All the high-tension three-core, low-tension concentric and telephone

FIG. 9.—VIEW OF END OF MOTOR CAR, SHOWING CONNECTION TO OVERHEAD CONNECTOR IN TRAIN SHED.

cables are laid in Howard asphalt troughing, with a separate trough for each cable. There are twenty-nine culverts in which the cables pass under railway lines, and in these cases a trench is excavated which is floored with concrete, and brick walls are built up on the side, on the top of

FIG. 11.—SHOWING TRACK CONSTRUCTION AND HYDRAULIC BOND PRESS.

which are laid old rails covered with concrete and a damp-proof course, to form a floor for the sleepers and rails. In this way all weight and pounding from the passing trains is kept off the cables.

The system of supply to the train collecting shoes is the same as that already in use on the Metropolitan and District railways. There are two insulated conductor rails, the positive being three inches above rail level and sixteen inches outside the running rail, and the negative conductor being one and one-half inches above rail level and in the centre of the track. The two conductor rails are of an inverted channel section, resting at intervals not exceeding ten feet on iron-capped porcelain insulators, which are fixed to the sleepers by small clamps and coach screws. This design leaves the conductor rail and insulator free to move up and down relatively to each other when trains are passing, owing to the spring in the sleepers and in the road bed. The rails weigh 102.8 pounds per yard. The conductor rails are fished by a joint plate bolted on the under side, and are bonded by four laminated copper strip bonds. At intervals of about 130 feet the conductor rails are anchored by means of special insulators having a groove in the iron cap, in which a bolt engages which passes through the flanges of the conductor rail, the anchor insulator being secured to the sleeper by semi-circular clips. The bond terminals were expanded into the conductor rails by means of hydraulic presses of two types. One consisted of a combined press and pump, which was used when the trains were not running, and which could be readily removed by means of runners along the surface of the rail and have centres of the rams quickly adjusted to the bond terminals. The other type consisted of a specially designed press worked by a separate pump, and so arranged that it could be used on the positive conductor rail without removing it when trains passed.

Each train is composed of six cars, approximately fifty-two feet long and eight feet nine inches, extreme width. Each car is carried on two four-wheel bogies, those of the front and rear cars each being equipped with two motors. The train itself weighs about 174 tons with electrical equipment complete, and with its full load of 160 passengers, an additional weight of thirty tons. The electrical equipment is of the British Thomson-Houston "M" multiple-control type, the eight motors on the train being controlled from one or other end of the train. There are in all twenty trains.

In the new train sheds built by the Great Western Railway at Hammersmith electric current is supplied to the trains by means of positive and negative overhead trolley wires, supported by wooden battens and bridge hangers. Current is collected from these trolley wires by means of small trolleys on four wheels, which run on the bottom flange of the joists, and to which are attached grooved rubbing contacts or collectors mounted on springs and insulators. From these collectors the current is conveyed to the

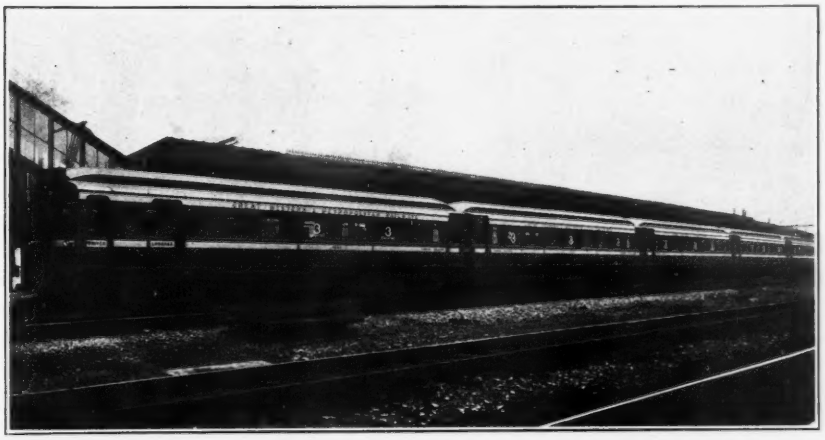


FIG. 10.—ELECTRIC TRAIN AT ROYAL OAK STATION.

trains by means of two flexible cables, bound together with leather braiding and reinforced by a stranded steel wire. To the bottom ends of the cable are attached the standard train cable plugs, which allow a connection to be made to either end, or either side, of any car, and by means of a special attachment it is impossible to insert the plug in the train in such a manner as to reverse the polarity of the circuits. As the sockets on the trains are not arranged to allow the plugs to pull out in an upward direction, a safety coupling has been inserted in each pair of cables, which breaks the circuit and releases the trolley from the train should the latter run right out of the shed without detaching the trolley.

Messrs. Kennedy & Jenkin, to whom we have already referred, have acted as consulting engineers for the Great Western Railway Company in these matters, but the rolling stock, buildings and trench work were under the supervision of the railway's own officials and staff.

ALBERT H. BRIDGE.

London, England, August 3.

Boiler, Engine and Generator Testing and Management—VI.

By Charles L. Hubbard.

Valve-Setting—*Concluded.*

WE have already seen that with the ordinary slide-valve it is impossible to change one event of the stroke without affecting to a greater or less extent all of the others. In the case of slow or medium-speed engines it is desirable to have a uniform point of release and a constant compression. If the engine is of the automatic cut-off type, the point of cut-off must necessarily change with every variation of load, so in order to make this independent of the other events, a *riding cut-off*, so called, is used. A diagram of this arangement is shown in Fig. 4. The main valve determines the lead, point of release, and exhaust closure; the duty of the cut-off valve being simply to close the ports of the main valve at the proper time. With these points in mind, it is evident that the main valve of a riding cut-off arrangement is the same as the ordinary slide-valve, having a fixed travel. The cut-off valve is also fixed, so far as the length of stroke is concerned, but the times of closing the ports in the main valve are variable and are determined either by hand adjustment or automatically, depending upon whether the engine is provided with a throttling or automatic shaft-governor.

The point of cut-off is changed by moving the eccentric of the cut-off valve around on the shaft. The greater the angular advance of this eccentric in relation to the crank, the earlier the point of cut-off; and the nearer together the eccentrics of the two valves are set, the later the point of cut-off.

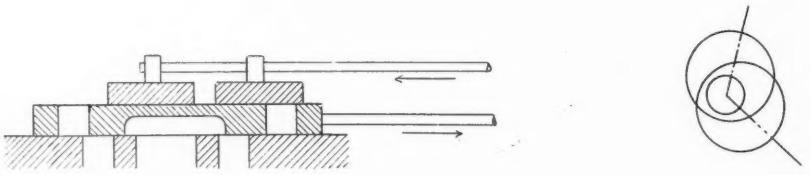


FIG. 4.—METHOD OF USING RIDING CUT-OFF WITH AUTOMATIC ENGINE.

The main valve is generally designed to cut-off at two-thirds to three-fourths stroke, so that if the two valves are set together, the point of cut-off will be that determined by the main valve.

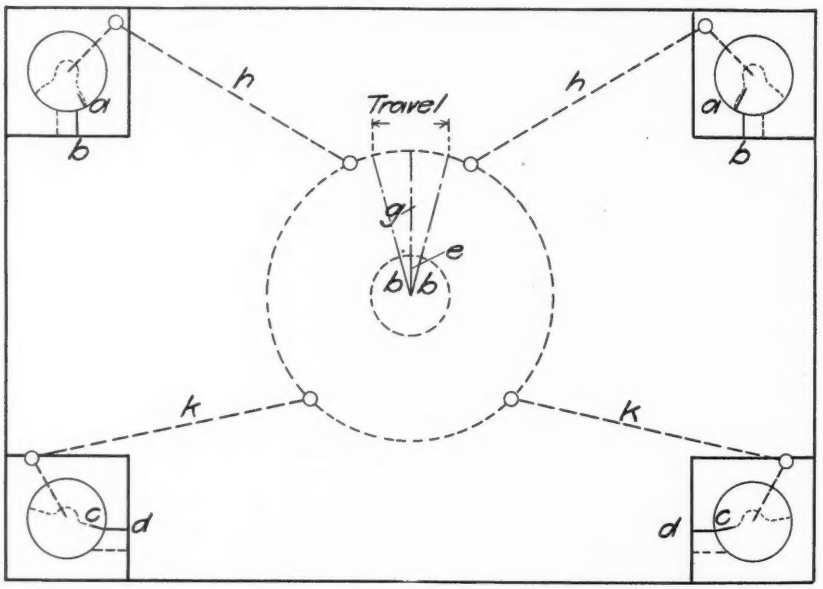


FIG. 5.—SETTING THE VALVES OF A CORLISS ENGINE.

If the cut-off valve be set in advance of the main valve, it will reach the end of its stroke first and meet the main valve on its return stroke, and the point in the stroke of the piston at which the centres of the two valves pass each other will be the point of cut-off.

The method of setting a valve of this type is in part the same as for the ordinary slide-valve. The main valve is first set for equal lead in the manner already described, and here it may be well to mention a method of marking the position of the valve for furnishing a quick and simple means of setting in case the eccentric should slip on the shaft at some future time.

After the valve has been set for equal lead, revolve the shaft until the valve is at one extreme of its travel; then put a punch mark on the side of the stuffing-box, and, placing one end of a gauge in this mark, draw a fine line on the valve stem with the other end. Next turn the shaft forward till the valve reaches the end of its stroke in the opposite direction and mark a point on the valve stem as before; these two points, as well as a third, midway between them, should now be permanently marked by means of a prick punch. By placing the ends of the gauge in the point of the stuffing-box and in the centre mark on the valve stem the valve can be brought to its central position without removing the cover of the steam chest. Having set the main valve, the cut-off valve is set for equal travel in exactly the same manner, and the next step is to adjust the eccentric to give the desired point of cut-off.

First revolve the shaft in the direction the engine is to run until the cross-head reaches the point in the stroke at which cut-off is to occur, and which should be indicated by a mark on the guide. Next turn the cut-off eccentric in the same direction until it reaches its extreme position; continue this movement until the cut-off valve just closes the port in the main valve. The eccentric should now be secured to the shaft and the latter revolved until cut-off takes place on the return stroke. If this occurs at the same position of the piston as before, the valve is properly set. If not, adjust the length of the valve stem an amount equal to half the difference.

The above applies only to cases where a throttling governor is used and where the cut-off is adjusted by hand. When the cut-off valve is operated by an automatic

shaft-governor the valve travel is first equalized as described above, and the engine placed on one of its dead centres. The main valve, which is always set first, will now be open an amount equal to the lead. The governor weights should now be blocked against the outer stops, and the full side of the cut-off eccentric turned to correspond with the main crank, as a starting point. The eccentric should now be turned on the shaft in the direction it is to run until the port in the main valve is open to the extent of the lead; then secure the eccentric to the shaft. Then turn the crank over until the engine is on its other dead centre and see if the cut-off valve opens the port in the main valve to the same extent. If the opening is not the same, the length of the valve stem should be adjusted an amount equal to one-half the difference. The valve is now set and the blocking may be removed from the governor weights.

The position of the valve stem should be marked for the points of cut-off on both the forward and return stroke as already described for the main valve.

Fig. 5 shows in diagram the arrangement of valves and wrist-plate for an engine of the Corliss type with single wrist-plate. When the back bonnets of the valve chambers are removed, most engines will be found to have marks stamped in the metal, showing the positions of the working edges of both valves and ports. For example—*a a* and *b b* show the edges, respectively, of the steam valves and ports, and *c c* and *d d* show the edges of valves and ports for the exhaust in a similar manner.

On the stud upon which the wrist-plate turns will be found three lines, *e* and *f f*, in such a position that when the line *e* coincides with the line *g* on the wrist-plate, the latter will be in its mid-position, and when line *g* corresponds with the lines *f* and *f*, it will be at the extreme limit of its travel in each direction.

The first step in setting a valve of this type is to place the wrist-plate in its central position, with *e* coinciding with the line *g*. The wrist-plate should now be secured in position by inserting a heavy paper washer under the nut and washer upon the stud. Next set the steam valves so they will have a slight lap, which should vary from one-sixteenth to one-fourth inch in engines of smaller size, to three-eighths inch in those of large size. This adjustment is made by lengthening or shortening the rods *h h* as the case may be.

The exhaust valves should now be set so that the lines *c* and *d*, or in other words, the working edges of the valves and ports are just in line.

After this the rocker arm should be adjusted. This may be set in a vertical position by means of a plumb line and the eccentric rod connected with it. The shaft should then be rotated and an examination made to see if the rocker arm travels equal distances each side of the plumb line. If not, the length of the rod should be given the proper length to secure this result. The hook rod should now be connected with the wrist-plate, and the paper washer removed in order that it may move freely upon its stud. The shaft is then slowly rotated to see if the extreme travel of the wrist-plate is correct. If all the parts have been properly adjusted, the line *g* will coincide with the lines *f f* at the extreme points of travel. If this is not the case, the hook rod must be so adjusted as to equalize the motion of the wrist-plate. After this is done, the next step is to see that the valves are properly adjusted with reference to the crank. This is done by placing the engine on one of its dead centres and turning the eccentric loosely on the shaft in its normal direction until the steam valve nearest the piston shows the desired lead. The eccentric should now be secured in position and the shaft revolved in the same direction until the engine is on the other dead centre. If the other steam valve shows the same lead as the first, this part of the operation is completed; if not, the length of the arm *h* should be shortened or lengthened slightly to give the proper adjustment to the valve. If much change is required, the valves should again be set with reference to the wrist-plate and the above operation repeated.

Attention should now be given to the exhaust valves, which are set to give the desired amount of compression. This will depend somewhat upon the type of engine and also largely upon the experience of the engineer in connection with the particular engine under consideration. Suppose, for example, that it is desired to have compression begin three inches before the piston has reached the end of its return stroke. First measure off this distance from the ends of the cross-head travel and mark it upon one of the guides. Then turn the shaft in the direction the engine is to run until the end of the cross-head coincides with the mark on the guide; adjust the valve corresponding to this end of the stroke so that it just closes the port. Now turn the shaft over until the point of compression is reached at the other end of the stroke and repeat the adjustment upon the other valve.

These adjustments are made by lengthening or shortening the arms *k k* as may be required. The next and last step is to adjust the cam rods leading from the governor so that cut-off will occur at the same point in both the forward and return strokes. Unhook the reach rod from the wrist-plate and by means of the starting-bar turn the wrist-plate over until the lines *g* and *f* are nearly in line. When in this position the head-end valve should have nearly its maximum opening. The length of the cam rod should now be adjusted so that the valve will trip and cut-off occur when *g* and *f* coincide. The cut-off motion of the other valve should now be adjusted in a similar manner.

To prove that the adjustment has been properly made, the governor balls should be raised to their normal position when the engine is running at speed, and blocked in place; then with the connections made between the eccentric and wrist-plate, turn the shaft slowly in its normal direction and note the points in the stroke at which the cut-off takes place in both the forward and return movement of the piston. If these points are equally distant in each case from the beginning of the stroke, the valves are in proper adjustment. If not, the lengths of the cam rods should be made such as to produce the desired result. The bonnets should now be replaced over the valves, which completes the operation.

When an engine has two eccentrics, the admission valves and exhaust valves are adjusted separately. The process is practically the same for each as already described. The exhaust valves are commonly set first, as the eccentric is usually placed next to the bearing.

The various methods given have necessarily been more or less general, but with a little study can be readily adapted to many of the more common designs of valve gears.

American Electrochemical Society.

A preliminary announcement of the fall meeting of the American Electrochemical Society has been made. These fall meetings are to be held in New York city this year. This year, if no change is made later, the meeting will open on the evening of October 10 with a session at the Chemists' Club, to be followed by sessions on Friday morning and evening, October 11, and Saturday morning, October 12. Friday afternoon will be devoted to visits to industrial plants. A full programme of papers is being prepared. The secretary of the society is Dr. Joseph W. Richards, Lehigh University, South Bethlehem, Pa.

THE BRITISH ASSOCIATION.[1]

BY SILVANUS P. THOMPSON.

It would be impossible for any assembly of engineers to meet in annual gathering at the present time without some reference to the severe loss which the profession has so recently sustained by the death of Sir Benjamin Baker. Born in 1840, he had attained while still a comparatively young man to a position in the front rank of constructive engineers. His contributions to science cover a considerable range, but were chiefly concerned with the strength of materials, into which he made valuable investigations, and with engineering structures generally. His name will doubtless be chiefly associated with the building of great bridges, to the theory of which he contributed an important memoir, entitled "A Theoretical Investigation into the Most Advantageous System of Constructing Bridges of Great Span." In this work he set forth the theory of the cantilever bridge. Upon the plan there laid down he built the Forth bridge, besides many other large bridges in various parts of the world. With that memorable structure, completed in 1890, his name will ever be associated; but he will be remembered henceforth also as the engineer who was responsible for the great dam across the Nile at Assouan, a work which promises to have an influence for all time upon the fortunes of Egypt and upon the prosperity of its population. Sir Benjamin Baker was, moreover, closely associated with the internal railways of London, both in the early days of the Metropolitan Railway and in the later developments of the deep-level tubes. He was elected a Fellow of the Royal Society in 1890, became president of the Institution of Civil Engineers in 1895, and was a member of council of the Institution of Mechanical Engineers, besides being an active member of the Royal Institution and of the British Association. He was also a member of the Council of the Royal Society at the time of his death.

He enjoyed many honorary distinctions, including degrees conferred by the universities of Cambridge and Edinburgh. In 1890 there was conferred upon him the title of K.C.M.G., and in 1902 that of K.C.B.

He had but just returned from Egypt, whither he had gone in connection with the project for raising the height of the Assouan dam, so as to increase its storage to more than double the present volume, when he died very suddenly on May 19, in his sixty-seventh year.

[1] Address by the president of the Engineering Section, British Association for the Advancement of Science, Leicester, England, August 1, 1907.

THE DEVELOPMENT OF ENGINEERING AND ITS FOUNDATION ON SCIENCE.

We live in an age when the development of the material resources of civilization is progressing in a ratio without parallel. International commerce spreads apace. Ocean transport is demanding greater facilities. Steamships of vaster size and swifter speed than any heretofore in use are being built every year. Not only are railways extending in all outlying parts of the world, but at home, where the territory is already everywhere intersected with lines, larger and heavier locomotives are being used, and longer runs without stopping are being made by our express trains. The horse cars on our tramways are now being mostly superseded by larger cars, electrically propelled and traveling with greatly increased speeds. For the handling of the ever-increasing passenger traffic in our great cities, electric propulsion has shown itself a necessity of the time; witness the electric railways in Liverpool and the network of electrically worked tube railways throughout London. In ten years the manufacture of automobile carriages of all sorts has sprung up into a great industry. Every year sees a greater demand for the raw materials and products, out of which the manufacturer will, in turn, produce the articles demanded by our complex modern life. We live and work in larger buildings; we make more use of mechanical appliances; we travel more, and our traveling is more expeditious than formerly; and not we alone, but all the progressive nations. The world uses more steel, more copper, more aluminum, more paper; therefore requires more coal, more petroleum, more timber, more ores, more machinery for the getting and working of them; more trains and steamships for their transport. It requires machines that will work faster or more cheaply than the old ones to meet the increasing demands of manufacture; new fabrics, new dyes, even new foods, new and more powerful means of illumination, new methods of speaking to the ends of the earth.

We must not delude ourselves with imagining that the happiness and welfare of mankind depend only on its material advancement; or that moral, intellectual and spiritual forces are not in the ultimate resort of greater moment. But if the inquiry be propounded, what it is that has made possible this amazing material progress, there is but one answer that can be given—science. Chemistry, physics, mechanics, mathematics, it is these that have given to man the possibility of organizing this tremendous development. And the great profession which has been most potent in applying these branches of science to wield the energies of Nature and direct them to the service of man has been that of the engineer. Without the engineer, how little of all this activity could there have been? And without mathematics, mechanics, physics and chemistry, where were the engineer?

If in looking over this England of Edward the Seventh we try to put ourselves back into the England of Edward the Sixth—or, for that matter, of any pre-Victorian monarch—we must admit that the difference to be found in the social and industrial conditions around us are due not in any appreciable degree to any changes in politics, philosophy, religion or law, but to science and its applications. If we look abroad, and contrast the Germany of Wilhelm the Second with the Germany of Charles the Fifth, we shall come to the like conclusion. So also in Italy, in Switzerland—in every one, indeed, of the progressive nations. And it is precisely in the stagnant nations, such as Spain or Servia, where the cultivation of science has scarcely begun, that the social conditions remain in the backward state of the Middle Ages.

INTERACTION OF ABSTRACT SCIENCE AND ITS APPLICATIONS.

In engineering, above all other branches of human effort, we are able to trace the close interaction between abstract science and its practical applications. Often as the connection between pure science and its applications has been emphasized in addresses upon engineering, the emphasis has almost always been laid upon the influence of the abstract upon the concrete. We are all familiar with the doctrine that the progress of science ought to be an end in itself; that scientific research ought to be pursued without regard to its immediate applications; that the importance of a discovery must not be measured by its apparent utility at the moment. We are assured that research in pure science is bound to work itself out in due time into technical appliances of utility, and that the pioneer ought not to pause in his quest to work out potential industrial developments. We are invited to consider the example of the immortal Faraday, who deliberately abstained from busying himself with marketable inventions arising out of his discoveries, excusing himself on the ground that he had no time to spare for money-making. It

is equally true, and equally to the point, that Faraday, when he had established a new fact or a new physical relation, ceased from busying himself with it, and pronounced that it was now ready to be handed over to the mathematicians. But, admitting all these commonplaces as to the value of abstract science in itself and for its own sake, admitting also the proposition that sooner or later the practical applications are bound to follow on upon the discovery, it yet remains true that in this thing the temperament of the discoverer counts for something. There are scientific investigators who can not pursue their work if troubled by the question of ulterior applications; there are others, no less truly scientific, who simply can not work without the definiteness of aim that is given by a practical problem awaiting solution. There are Willanses as well as Regnaults; there Whitworths as well as Poissons. The world needs both types of investigator; and it needs, too, yet another type of pioneer—namely, the man who, making no claim to original discovery, by patient application and intelligent skill turns to industrial fruitfulness the results already attained in abstract discovery.

There is, however, another aspect of the relation between pure and applied science, the significance of which has not been hitherto so much emphasized, but yet is none the less real—the reaction upon science and upon scientific discovery of the industrial applications. For while pure science breeds useful inventions, it is none the less true that the industrial development of useful inventions fosters the progress of pure science. No one who is conversant with the history, for example, of optics can doubt that the invention of the telescope and the desire to perfect it were the principal factors in the outburst of optical science which we associate with the names of Newton, Huygens and Euler. The practical application, which we know was in the minds of each of these men, must surely have been the impelling motive that caused them to concentrate on abstract optics their great and exceptional powers of thought. It was in the quest—the hopeless quest—of the philosopher's stone and the elixir of life that the foundations of the science of chemistry were laid. The invention of the art of photography has given immense assistance to sciences as widely apart as meteorology, ethnology, astronomy, zoology and spectroscopy. Of the laws of heat men were profoundly ignorant until the invention of the steam engine compelled scientific investigation; and the new science of thermodynamics was born. Had there been no industrial development of the steam engine, is it at all likely that the world would ever have been enriched with the scientific researches of Rankine, Joule, Regnault, Hirn or James Thomson? The magnet had been known for centuries, yet the study of it was utterly neglected until the application of it in the mariners' compass gave the incentive for research.

The history of electric telegraphy furnishes a very striking example of this reflex influence of industrial applications. The discovery of the electric current by Volta, and the investigation of its properties, appear to have been stimulated by the medical properties attributed, in the preceding fifty years, to electric discharges. But, once the current had been discovered, a new incentive arose in the dim possibility it suggested of transmitting signals to a distance. This was certainly a possibility, even when only the chemical effects of the current had yet been found out. Not, however, until the magnetic effects of the current had been discovered and investigated did telegraphy assume commercial shape at the hands of Cooke and Wheatstone in England and of Morse and Vail in America. Let us admit freely that these men were inventors rather than discoverers; exploiters of research rather than pioneers. They built upon the foundations laid by Volta, Oersted, Sturgeon, Henry, and a host of less famous workers. But no sooner had the telegraph become of industrial importance, with telegraph lines erected on land and submarine cables laid in the sea, than fresh investigations were found necessary; new and delicate instruments must be devised; means of accurate measurement heretofore undreamt of must be found; standards for the comparison of electrical quantities must be created; and the laws governing the operations of electrical systems and apparatus must be investigated and formulated in appropriate mathematical expressions. And so, perforce, as the inevitable consequence of the growth of the telegraph industry, and mainly at the hands of those interested in submarine telegraphy, there came about the system of electrical and electromagnetic units, based on the early magnetic work of Gauss and Weber, developed further by Lord Kelvin, by Bright and Clark, and last, but not least, by Clerk Maxwell. Had there been no telegraph industry to force electrical measurement and electrical theory to the front, where would Clerk Maxwell's work have been? He would probably have given his unique powers to the study of optics or geometry; his electromagnetic theory of light would never have leaped into his brain; he would never have propounded the existence of electric waves in the ether. And then we should never have had the far-reaching investigations of Heinrich Hertz; nor would the British Association at Oxford, in 1894, have witnessed the demonstration of wireless telegraphy by Sir Oliver Lodge. A remark by Lord Rayleigh may here be recalled: that the invention of the telephone had probably done more than anything else to make electricians understand the principle of self-induction.

In considering this reflex influence of the industrial applications upon the progress of pure science, it is of some significance to note that for the most part this influence is entirely helpful. There may be sporadic cases where industrial conditions tend temporarily to check progress by imposing persistence of a particular type of machine or appliance; but the general trend is always to help to new developments. The reaction aids the action; the law that is true enough in inorganic conservative systems, that reaction opposes the action, ceases here to be applicable, as indeed it ceases to be applicable in a vast number of organic phenomena. It is the very instability thereby introduced which is the essential of progress. The growing organism acts on its environment, and the change in the environment reacts on the organism—not in such a way as to oppose the growth, but so as to promote it. So is it with the development of pure science and its practical applications.

In further illustration of this principle one might refer to the immense effect which the engineering use of steel has had upon the study of the chemistry of the alloys. And the study of the alloys has in turn led to the recent development of metallography. It would even seem that through the study of the intimate structure of metals, prompted by the needs of engineers, we are within measurable distance of arriving at a knowledge of the secret of crystallogenesis. Everything points to the probability of a very great and rapid advance in that fascinating branch of pure science at no distant date.

HISTORY OF THE DEVELOPMENT OF ELECTRIC MOTIVE POWER.

There is, however, one last example of the interaction of science and industry which may claim closer attention. In the history of the development of the electric motor one finds abundant illustration of both aspects of that interaction.

We go back to the year 1821, when

Faraday, after studying the phenomena of electromagnetic deflection of a needle by an electric current (Oersted's discovery), first succeeded in producing continuous rotations by electromagnetic means. In his simple apparatus a piece of suspended copper wire, carrying a current from a small battery, and dipping at its lower end into a cup of mercury, rotated continuously around the pole of a short bar-magnet of steel placed upright in the cup. In another variety of this experiment the magnet rotated around the central wire, which was fixed. These pieces of apparatus were the merest toys, incapable of doing any useful work; nevertheless, they demonstrated the essential principle, and suggested further possibilities. Two years later, Barlow, using a star-wheel of copper, pivoted so that the lowest point of the star should make contact with a small pool of mercury, found that the star-wheel rotated if a current was sent through the arm of the star, while the arm itself was situated between the poles of a steel horseshoe magnet. Shortly afterwards Sturgeon improved the apparatus by substituting a copper disc for the star-wheel. The action was the same. A conductor, carrying an electric current, if placed in a magnetic field, is found to experience a mechanical drag, which is neither an attraction nor a repulsion, but a lateral force tending to move it at right angles to the direction of flow of the current, and at right angles to the direction of the lines of the magnetic field in which it is situated. Still this was a toy. Two years later came the announcement by Sturgeon of the invention of the soft-iron electromagnet, one of the most momentous of all inventions, since upon it practically the whole of the constructive part of electrical engineering is based. For the first time mankind was furnished with a magnet the attractive power of which could be increased absolutely indefinitely by the mere expenditure of sufficient capital upon the iron core and its surrounding copper coils, and the provision of a sufficiently powerful source of electric current to excite the magnetization. Furthermore, the magnet was under control, and could be made to attract or to cease to attract at will by merely switching the current on or off; and, lastly, this could be accomplished from a distance, even from great distances away. How slowly the importance of this discovery was recognized is now a matter for astonishment. To state that Sturgeon died in poverty twenty-six years later is sufficient to indicate his place among the unrequited pioneers of whom the world is not worthy. Six years elapsed, and then there came a flood of suggestions of electric motors in which was applied the principle of intermittent attraction by an electromagnet. Henry, in 1831, and Dal Negro, in 1832, produced see-saw mechanisms so operated. Ritchie, in 1833, and Jacobi, in 1834, devised rotatory motors. Ritchie pivoted a rapidly commutated electromagnet between the poles of a permanent magnet—a true type of the modern motor—while Jacobi caused two multipolar electromagnets, one fixed, one movable, to put a shaft into rotation and propel a boat. A perplexing diminution of the current of the battery whenever the motor was running caused Jacobi to investigate mathematically the theory of its action. In a masterly memoir he laid down a few years later the theory of electric motive power. But in the intervening period, in 1831, Faraday had made the cardinal discovery of the mechanical generation of electric currents by magneto-electric induction—the fundamental principle of the dynamo. Down to that date the only known way—save for the feeble currents of thermopiles—to generate electric currents had been the pile of Volta, or one of the forms of battery which had been evolved from it. Now, by Faraday's discovery, the world had become possessed of a new source. And yet again, strange as it may seem, years elapsed before the world—that is, the world of engineers—discovered that an important discovery had been made. Not till some thirty years later were any magnetoelectric machines made of a sufficient size to be of practical service even in telegraphy, and none was built of a sufficient power to furnish a single electric light until about the year 1857. In the meantime, in America, other electric motors, to be driven by batteries, had been devised by Davenport and by Page; the latter's machine had an iron plunger to be sucked by electromagnetic attraction into a hollow coil of copper wire, thereby driving a shaft and flywheel through the intermediate action of a connecting rod and crank. Page's was, in fact, an electric engine, with a two-foot stroke, single-acting, of between three and four horse-power. The battery occupied about three cubic feet, and consumed, according to Page, three pounds of zinc per horse-power per day. This must have been an underestimate, for if Daniell's cells were used, the minimum consumption for a motor of 100 per cent efficiency is known to be about two pounds of zinc per horse-power per hour.

ELECTRIC MOTIVE POWER IMPOSSIBLE IN 1857.

Upon the state of development of electric motors fifty years ago information may be gleaned from an exceedingly interesting debate at the Institution of Civil Engineers upon a paper read April 21, 1857, "On Electromagnetism as a Motive Power," by Mr. Robert Hunt, F.R.S. In this paper the author states that, though long-enduring thought has been brought to bear upon the subject, and large sums of money have been expended on the construction of machines, "yet there does not appear to be any nearer approach to a satisfactory result than there was thirty years ago." After explaining the elementary principles of electromagnetism, he describes the early motors of Dal Negro, Jacobi, Davenport, Davidson, Page and others. Reviewing these and their non-success as commercial machines, he says: "Notwithstanding these numerous trials . . . it does not appear that any satisfactory explanation has ever been given of the causes which have led to the abandonment of the idea of employing electricity as a motive power. It is mainly with the view of directing attention to these causes that the present communication has been written." He admits that electromagnets may be constructed to give any desired lifting power; but he finds that the attractive force on the iron keeper of a magnet of his own, which held 220 pounds when in contact, fell to thirty-six pounds when the distance apart was only one-fiftieth of an inch. To this rapid falling off of force, and to the hardening action on the iron of the repeated vibrations due to the mechanical concussion of the keeper, he attributed the small power of the apparatus. Also, he remarked upon the diminution of the current which is observed to flow from the battery when the motor was running (which Jacobi had, in his memoir on the theory, traced to a counter electromotive force generated in the motor itself), and which reduced the effort exerted by the electromagnets; this diminution he regarded as impairing the efficiency of the machine. "All electromagnetic arrangements," he says, "suffer from the cause named, a reduction of the mechanical value of the prime mover in a manner which has no resemblance to any of the effects due to heat regarded as a motive power." Proceeding to discuss the batteries, he remarked that as animal power depends on food, and steam power on coal, so electric power depends on the amount of zinc consumed; in support of which proposition he cited the experi-

ments of Joule. He gives as his own results that for every grain of zinc consumed in the battery his motor performed a duty equivalent to lifting eighty-six pounds one foot high. Joule and Scoresby, using Daniell's cells, had found the duty to be equivalent to raising eighty pounds one foot high, being about half the theoretical maximum duty for one grain of zinc. In the Cornish engine, doing its best duty, one grain of coal was equivalent to a duty of raising 143 pounds one foot high. He put the price of zinc at £35 per ton, as compared with coal at less than £1 per ton, which makes the cost of power produced by an electric motor—if computed by the consumption of zinc in a battery—about sixty times as great as that of an equal power produced by a steam engine consuming coal. He concludes that "it would be far more economical to burn zinc under a boiler, and to use it for generating steam power, than to consume zinc in a battery for generating electromagnetical power."

In the discussion which followed several men of distinction took part. Professor William Thomson, of Glasgow (Lord Kelvin), wrote, referring to the results of Joule and Scoresby: "These facts were of the highest importance in estimating the applicability of electromagnetism, as a motive power, in practice; and, indeed, the researches alluded to rendered the theory of the duty of electromagnetic engines as complete as that of the duty of water-wheels was generally admitted to be. Among other conclusions which might be drawn from these experiments was this: that until some mode of producing electricity as many times cheaper than that of an ordinary galvanic battery as coal was cheaper than zinc, electromagnetic engines could not supersede the steam engine." W. R. Grove (Lord Justice Sir William Grove) remarked that a practical application of the science appeared to be still distant. The great desideratum, in his opinion, was not so much improvement in the machine as in the prime mover—the battery—which was the source of power. At present the only available use for this power must be confined to special purposes where the danger of steam and the creation of vapor were sought to be avoided, or where economy of space was a great consideration. Professor Tyndall agreed with the last speaker, but suggested that there might be some way of mitigating the apparent diminution of power due to the induction of opposing electromotive forces in the machine itself. C. Cowper spoke of some experiments, made by himself and E. A. Cowper, showing the advantage gained by properly laminating the iron cores used in the motor. He put the cost of electric power at £4 per horse-power per hour. He deprecated building electric motors with reciprocating movements and cranks; described the use of silver commutators and mentioned the need of adjusting the lead given to the contacts. There was, he said, no reason to suppose that electric motors could be made as light as steam engines. Even in the case of small motors of one-tenth or one-hundredth of a horse-power, for light work, where the cost of power was of small consequence, a boy or a man turning a winch would probably furnish power at a cheaper rate. Alfred Smee agreed that the cost would be enormous for heavy work. Although motive power could not at present be produced at the same expense on a large scale by the battery as by coal, still they were enabled readily to apply the power at any distance from its source. The telegraph might be regarded as an application of motive power transmitted by electricity. G. P. Bidder considered that there had been a lamentable waste of ingenuity in attempting to bring electromagnetism into use on a large scale. Mr. Joule wrote to say that it was to be regretted that in France the delusion as to the possibility of electromagnetic engines superseding steam still prevailed. He pointed out, as a result of his calorimeter experiments, that if it were possible so to make the electric engine work as to reduce the amount to a small fraction of the strength which it had when the engine was standing still, nearly the whole of the heat (energy) due to the chemical action of the battery might be evolved as work. The less the heat evolved as heat in the battery the more perfect the economy of the engine. It was the lower intensity of chemical action of zinc as compared with carbon, and the relative cost of zinc and coal, which decided so completely in favor of the steam engine. Mr. Hunt, replying to the speakers in the discussion, said that his endeavor has been to show that the impossibility of employing electromagnetism as a motive power lay with the present voltaic battery. Before a steam engine could be considered the boiler and furnace must be considered. So likewise must the battery if electric power were to become economical. Then the president, Robert Stephenson, wound up the discussion by remarking that there could be no doubt that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. The mechanical application seemed to involve almost insuperable difficulties. The force exhibited by electromagnetism, though very great, extended through so small a space as to be practically useless. A powerful magnet might be compared to a steam engine with an enormous piston, but with exceedingly short stroke—an arrangement well known to be very undesirable.

In short, the most eminent engineers in 1857 one and all condemned the idea of electric motive power as unpractical and commercially impossible. Even Faraday, in his lecture on "Mental Education," in 1854, had set down the magnetoelectric engine along with mesmerism, homeopathy, odylism, the caloric engine, the electric light, the sympathetic compass and perpetual motion as coming in different degrees among "subjects uniting more or less of the most sure and valuable investigations of science with the most imaginary and unprofitable speculation, that are continually passing through their various phases of intellectual, experimental or commercial development, some to be established, some to disappear and some to recur again and again, like ill weeds that can not be extirpated, yet can be cultivated to no result as wholesome food for the mind."

(To be concluded.)

The Rubber Industry of Singapore.

Vice-Consul-General G. E. Chamberlain, of Singapore, writes that the position of the rubber-planting industry on the Malay Peninsula at the end of the year 1906, compared with the previous year, is remarkable, as the following figures show:

In December, 1905, the total acreage of rubber planted on the peninsula was probably less than 50,000 acres, and in December, 1906, it was 99,230; thus during the year the acreage was practically doubled. The number of trees increased from 7,000,000 to 12,980,756. The output of dry rubber, which was about 150 tons in 1905, was, in 1906, 412 tons, an increase of nearly three times. The reason that while the acreage has nearly doubled the number of trees have not proportionately increased is that the number of trees planted per acre during 1906 was not so many as previously. Planters have begun to see the value of giving their trees plenty of room.

In the Federated Malay States there are 39,000 coolies employed regularly at estate work. Of these nearly 30,000 are Tamils, 4,000 Javanese, 1,500 Malays, and 3,400 Chinese, and the wages paid them are from eighteen cents to thirty cents gold per day. While large areas have been planted in rubber still larger areas, amounting at the end of 1906 to some 200,000 acres, have been applied for and granted for this cultivation.

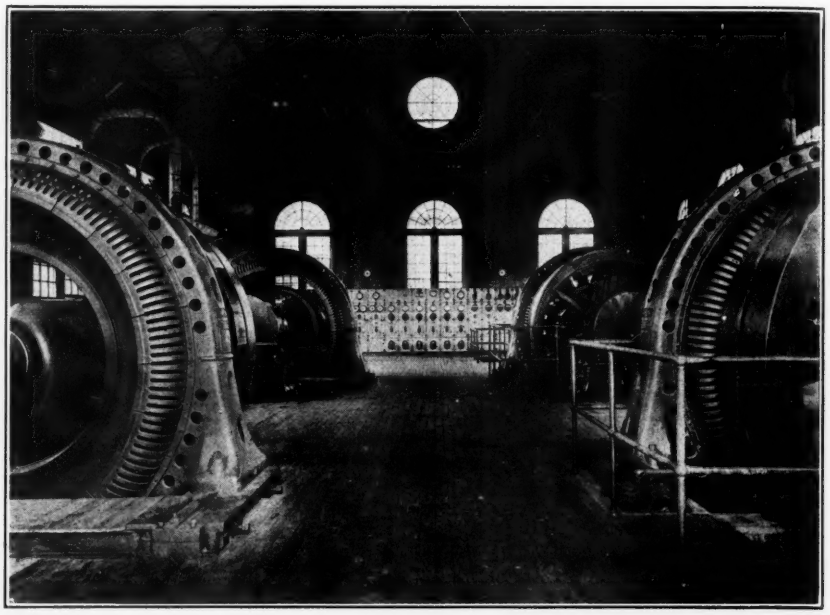
ALLIS-CHALMERS MACHINERY USED IN COAL AND COKE OPERATIONS.

BY W. B. SPELLMIRE.

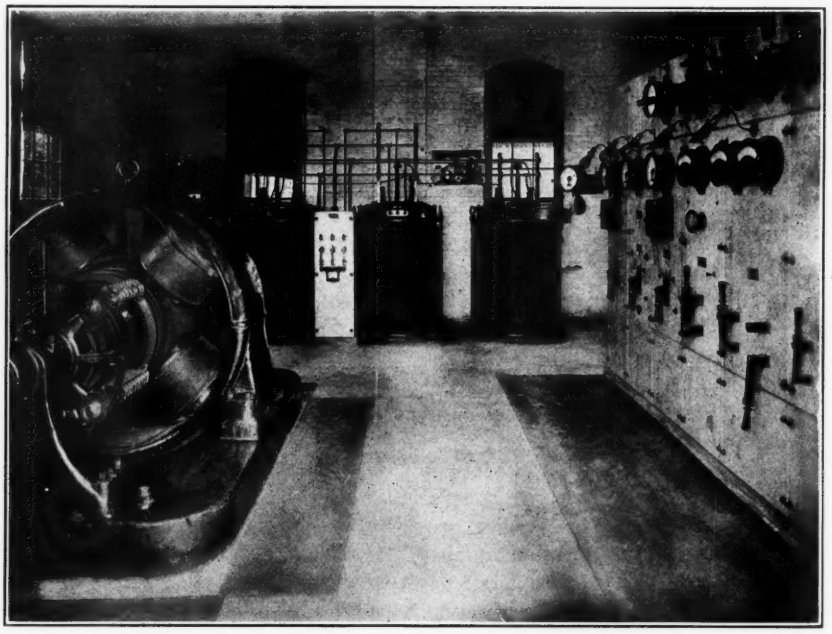
The total annual capacity for the production of pig iron by the United States Steel Corporation at the present time is about 25,000,000 tons. This enormous production makes the company a correspondingly large consumer of coke for use in its furnaces. With the exception of a comparatively small percentage all the coke which is used is supplied by its subsidiary companies. The two principal operators furnishing this coke are known as the H. C. Frick Coke Company and the United States Coal and Coke Company. The mines and works of the former are located in Pennsylvania, in what is known as the Connellsville district, largely comprising Fayette and Westmoreland counties. Those of the United States Coal and Coke Company are located at Gary, McDowell county, West Virginia. Both of these companies are operated along the same general lines. The H. C. Frick Coke Company at present owns about seventy separate coal mines, each mine having its own set of ovens which it supplies with coal. The number of ovens at each mine ranges from approximately 100 to 800, depending upon the output of the mine and other conditions. These are located close to the openings of the mines and conveniently arranged in relation to railroad sidings. The coke ovens are, with few exceptions, of the beehive type, into which the coal is introduced at the top. The residual heat and that of the adjoining ovens starts the coking process, in which the volatile portion of the coal is driven off through the top of the oven into the atmosphere. Then all of the volatile matter is driven off, the bed of coke is raked out at the bottom and loaded into cars for shipment.

The continued increase in furnace capacity of the steel corporation calls for a corresponding increase in coke production. It is estimated that the new furnaces under construction will add at least 2,000,000 tons to the present productive capacity of pig iron. This will necessitate between 6,000 and 7,000 more coke ovens with the necessary additional mining capacity and machinery equipment. Similar conditions prevail in respect to independent furnaces.

In coal mining power is used for operating haulage locomotives inside the mines, also for operating pumps which removes accumulations of water in the mines. A third requirement for power is for driving large ventilating fans. In shaft and slope mines power is also required for hoisting purposes. The dictates of modern practice are to use electric motors of proper design for all the above requirements. From the mine the coal is carried to a tipple, whence it is discharged into what are known as coke oven larries. These are small steel cars equipped with electric motors for propulsion and supplied with chutes for discharging the coal into the ovens. It is customary to arrange the ovens on either side of the track on which the larry runs; coal being discharged from both sides. The electric motors on the larries are small railway type machines. Electrically operated drawing machines are used for removing the coke from the ovens. The machine draws the coke out of the oven by a scraper, discharging it on to a conveying belt whence it is dumped directly into freight cars. Two motors are used



YORK RUN PLANT OF THE H. C. FRICK COKE COMPANY. VIEW SHOWING ARRANGEMENT OF FOUR 400-KILOWATT 2,200-VOLT ALLIS-CHALMERS ALTERNATORS.

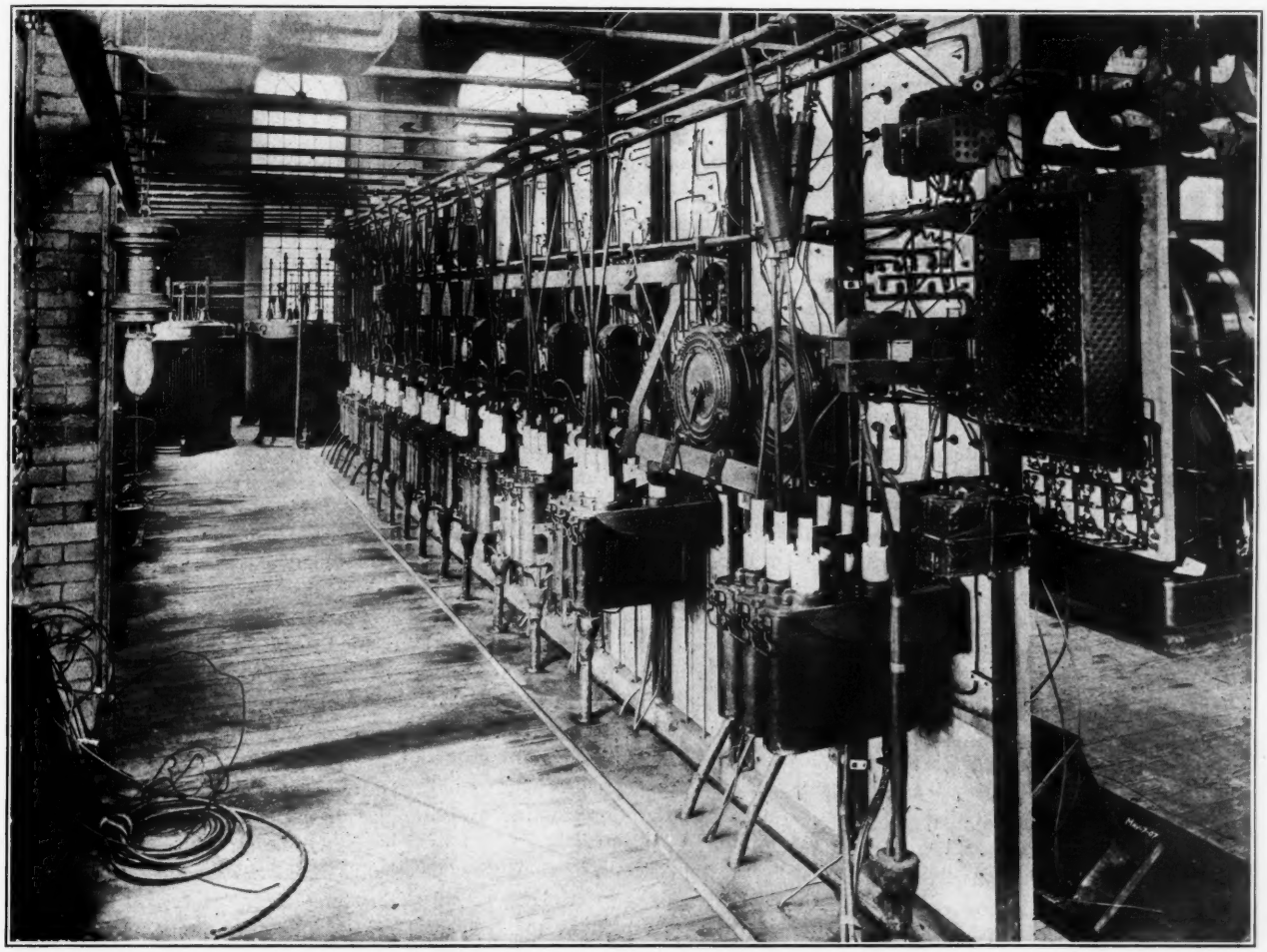


SUBSTATION, YORK RUN PLANT, H. C. FRICK COKE COMPANY.

on this machine; one is of the series-wound railway type and the other a shunt-wound constant-speed motor.

The operations of the H. C. Frick Coke Company at its York Run plant are of special interest on account of modern features. Of the ovens here 100 are especially selected and so connected by flues as to conduct the hot gases from the ovens to the boiler house. The heat discharged from the coke ovens represents an enormous waste, and its use under the boilers with motor and engine-driven exciters. In the main power-house is located a rotary-converter substation supplied with two 200-kilowatt rotary converters and six seventy-five-kilowatt step-down transformers. All the machinery in the power-house is controlled by a large seventeen-panel blue Vermont marble switchboard with complement of oil switches, indicating and recording meters. The rotary converters supply direct current at 600 volts for haulage locomotives and coke feeder lines. By means of integrating and recording meters a record of the power consumption is afforded at each mining and coking operation.

Additional mining and coking operations can be supplied from this same power-house by running additional high-tension lines. Instances arise, however, where this is not practicable. Where locations are too remote, or when intervening property can not be traversed by high-tension lines it becomes necessary to in-



View Showing Rear of Main Switchboard, York Run Plant of the H. C. Frick Coke Company.

therefore saves the use of a corresponding quantity of coal to produce the same heat; thus a large amount of heat is economically obtained at York Run. It is roughly estimated that the heat developed by each oven is the equivalent continuously of eighteen horse-power.

The complete electrical machinery equipment of the power-house and all the substations was built by Allis-Chalmers Company, Milwaukee, Wis.

The power-house is supplied with four Allis-Chalmers generators rated 400-kilowatt, 2,300-volt, three-phase, twenty-five cycles. The equipment is complete oven larries at the York Run mine. Alternating current is used for pumps, mine fans, hoists and scrapers. Within a radius of between two and three miles there are located at various points four additional rotary-converter substations; each is equipped with one 200-kilowatt rotary converter, three seventy-five-kilowatt step-down transformers and complete switchboard. These substations are located so as to supply both alternating and direct current for mining and coking operations required by one or more mines. The switchboard in the main station is provided with feeder panels for the substation stall separate isolated plants. A number of such plants are now being installed to meet the increased demand for coke. At the Phillips mines two 100-kilowatt, direct-current railway-type generators with switchboards are being installed; also at Ronco mines two 200-kilowatt, direct-current engine-type railway generators with switchboard are being started and at Dearth mines two 200-kilowatt, direct-current engine-type generators with switchboard. All of this electrical equipment is being supplied by the Allis-Chalmers Company.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

The Effect of Frequency on the Capacity of Absolute Condensers.

An investigation of the effect of frequency upon the capacity of absolute condensers has been made by J. G. Coffin. Two forms of condenser were studied, one in which the plates were rectangular, and the other circular. A complete analytical investigation of these has been made and the following conclusions reached. In order to attack the problem mathematically it was necessary to assume a simple case of a uniform strip, and that of an angular strip, this latter corresponding to a circular-plate condenser. The results show that when the surface resistance is high, the capacity falls off to an enormous extent at comparatively low frequencies. It has been found that the capacity of a condenser diminishes with increasing frequency as well as the self-inductance of the coil, so that their effects are additive; and in all work in which high-frequency currents are employed the experimenter must assure himself that the corrections pointed out are negligible for the work in question, or must allow for them.—*Abstracted from the Physical Review (Lancaster), August.*

Comparative Costs of Gasolene, Gas, Steam and Electricity for Small Powers.

A comparison is made here by William O. Webber of the comparative costs of gasolene, gas, steam and electricity when used for supplying small powers. The author has compiled tables showing the cost of each kind of power up to thirty horse-power, and upon the assumption that there are 3,080 working hours during the year. Figures are given in dollars per horse-power-year. The cost of gasolene is taken at from twenty-two to eighteen cents a gallon, according to quantity. Gas is taken at from $1.50 to $1.20 per 1,000 cubic feet. Coal is taken at $5 a ton, and electricity is charged for at thirteen and one-half cents a kilowatt-hour, with a discount increasing from ten per cent for a monthly bill of $5 up to sixty-five per cent for $500 and over. The author has brought his results together in a curve sheet, and from this it is seen that electric power is the cheapest up to three horse-power. From this point up to twelve horse-power gas is the cheapest, and from there on, gasolene. At ten horse-power, gasolene and electricity are equal, and both more expensive than gas. From this point the relative order of cheapness is gasolene, gas, electricity and steam.—*Abstracted from the Engineering News (New York), August 15.*

The Electrical Equipment of the Lusitania.

The new Cunard turbine-driven, quadruple-screw Atlantic liner Lusitania has used electric power wherever practicable. This steamer is equipped with a number of elevators, there being eleven in all, all operated by electric motors. Two of these are passenger elevators, which travel through a height of thirty-six feet between the main and boat decks. Special safety apparatus comes into operation should the lifting ropes fail. The car is raised by steel cables, which pass through the double dome of the staircase over top sheaves, and thence horizontally to the winding gear, which is fixed at the boat deck-house level. This gear consists of a drum of the worm-and-wheel type driven by an eight-horse-power motor. It runs at a speed of 150 feet a minute. The controller is magnetically operated from the car and an automatic magnetic brake is provided. There are two freight elevators running at 100 feet a minute, capable of lifting four tons, each operated by fifteen-horse-power motors. There are two service elevators running at the same speed as the baggage elevators, each capable of lifting 1,000 pounds, operated by a five-horse-power motor. There are three dumbwaiters, each driven by a one-and-one-half-horse-power motor. The ventilation of the ship is by means of steam pipes, around which air is circulated and distributed to the various parts of the vessel, the fans for this purpose being driven by motors. For lighting the vessel there are four generating sets, all alike, each rated at 375 kilowatts. The voltage employed is 110, and the generators are driven by Parsons turbines running at 1,200 revolutions a minute. Forced draft is used on the vessel, this being provided by means of fans driven by motors, there being thirty-two motor-driven fans arranged in pairs and driven by sixteen motors. They run at 450 revolutions a minute and the motors are capable of developing fifty brake-horse-power. There are four electrically operated boat-hoisting winches. The specific duty of these is to lift a load of twelve hundredweight at a speed of 250 feet a minute. Two warping drums are provided on each side, so as to distribute the pull over four ropes. The motors operating these winches are rated at fourteen horse-power and run at 600 revolutions a minute. The controller is of the railway type and is placed horizontally inside a special box under the motor. It is operated through bevel gear by means of a handle placed beside the winch. There are four deck cranes on this vessel operated by electric motors rated at fifteen horse-power.—*Abstracted from Engineering (London), August 2.*

Electric Street Lighting in London.

A report is given here of the recommendations of the Streets Committee of London with regard to an experimental display during the coming winter of the best forms of electric street lighting. At the Holborn viaduct flame arc lamps are to be erected on posts. In Farringdon street, including Holborn Circus and the Old Bailey, enclosed arc lamps are to be placed, and in Newgate street smaller lamps will be used. The charges for these lamps are at the rate of $87.50 a year for the flame arcs, and $62.50 and $52.50 a year for the other arc lamps, respectively. In Cannon street, below Budge row and St. Paul's churchyard, flame arcs are to be hung centrally. All costs for installation, including the posts, maintenance, etc., are to be borne by the lighting companies. The experiment is to continue until March next. A new method of suspending the flame arcs is to be tried. To prevent any swinging of the lamps two obliquely arranged wires will be provided, with the lamp hung at their intersection. Both of these wires are to be of steel. One is insulated from the lamp, and the other is used as the conductor as well as for holding the lamp. The use of two wires is thought to be an advantage, as, should one break, the other would hold the lamp.

Moreover, the uninsulated wire, being placed above, is expected to act as a guard wire to prevent telegraph or other overhead wires from falling across the conductor. No arrangment for lowering or drawing the lamps to one side for trimming has been arranged, as this is for the supply company to take care of.—*Abstracted from Electrical Engineering (London), August* 1.

Single-Phase versus Direct-Current Railway Operations.

In this article Malcolm MacLaren criticizes the conclusions reached in a book recently published by H. F. Parshall and H. M. Hobart on electric railway engineering, where the authors compare the single-phase and the direct-current systems. The basis of comparison is held by Mr. MacLaren to be not entirely fair; this should be upon cars having equal seating capacities. In this case reference is made to the Indianapolis & Cincinnati Traction Company's single-phase cars, which weigh forty-eight short tons complete with electrical equipment, or 104 tons for a two-car train with load. Each car is equipped with four 100-horse-power, single-phase motors, and the total weight of electrical equipment and wiring is 30,000 pounds per car, instead of the 33,600 pounds allowed by Messrs. Parshall and Hobart. Thus, with less weight of equipment, 800 horse-power per train was obtained instead of 450. If the cars were equipped with direct-current motors for the same schedule speed, ninety-horse-power motors would be suitable. These cars thus equipped have a total weight of eighty-six tons, as against ninety-six with the alternating-current equipment. Mr. MacLaren also criticizes the values given for the impedance of the line and track. He says that at twenty-five cycles the loss in potential due to the impedance is only one and one-half per cent, instead of thirteen per cent, the transmission voltage being 5,000; and when transmitting at 3,000 volts it would be only 4.3 per cent instead of thirty. Regarding the cost of the overhead equipment, there is little choice between the third rail properly protected and an overhead catenary construction with feeders. He then gives tables showing the comparative costs of the two systems for a sixty-mile road. The power station for the direct-current system will cost $115,000; for the alternating current, $79,200. The cost of the high-tension transmission line for the alternating-current system would be $19,800; for substations, $8,450. The direct-current system would have no substations, but instead three power stations, the total cost of which is given above. The low-tension distributing system would cost $242,700 for the direct-current and $182,700 for the alternating. These figures are based on sixty-three miles of overhead construction. The car equipment will cost $68,400 for the direct-current and $96,000 for the alternating, making a total cost for the direct-current system of $426,100 and for the alternating $386,150. He then estimates the yearly cost of operating the two systems, and finds that for the direct-current system this would be $52,113 and for the alternating $42,158. He therefore concludes that the single-phase, alternating-system is not only cheaper to install, but less expensive to operate for a road of the size under discussion.—*Abstracted from the Electric Journal (Pittsburg), August.*

Electric Power in Mexico.

It is pointed out here that the application of electric power is likely to have a far-reaching effect upon the mining industry of Mexico. The introduction years ago of the lixiviation process, and later the construction of large smelting works, each reduced the cost of mining and rendered available ores which before had been too poor or too refractory to handle at a profit. The use of cheap electric power is effecting another reduction in cost which will bring a great tonnage of material within the range of profitable treatment. There is no better climate for mining operations than that of the mining regions of Mexico, and labor is excellent and cheap. The only factor necessary to make the conditions ideal for mining and metallurgical industries is a supply of fuel and power. The country's resources of coal and oil have not yet been sufficiently developed to satisfy the needs of metal mining. Power costs have been high. The utilization of power from the rivers and streams on the east and west slopes of the central plateau promises to remove this last disadvantage and to render the country as suitable for industrial purposes as any other region of the world. The perfection of an electrical process for the production of iron and steel opens an attractive field in Mexico. Raw material of all kinds, except coking coal, is at hand in abundance, and there is a growing demand for superior grades of steel. With sufficient sources of current and practical methods of converting iron ore into steel there is no place in the world where the industry will be more likely to flourish than in Mexico.—*Abstracted from the Engineering and Mining Journal (New York), August* 10.

The Variations of Manganin Resistances with Atmospheric Humidity.

A reply is made here by W. Jaeger and S. Lindeck to a recent publication by Messrs. Rosa and Babcock, in which the variation in the higher resistances of the Reichsanstalt form in the climate of Washington was discussed. The amplitude of the variation found was said to be from 0.01 to 0.02 per cent, an increase in humidity causing an increase in resistance. The manganin itself plays no part in this phenomenon. The changes described seemed to be excessive, and as a result an investigation was made at the Reichsanstalt laboratories in order to check the changes mentioned. First it is pointed out that the change in humidity at these laboratories is much less than that at Washington, as a humidity of from sixty-five to seventy per cent was noticed during a few days only. The variation throughout the year was from twenty-two in February to fifty-eight in August, these figures being the average for the months. Measurements were made on ten standard resistances, which were calibrated with the utmost precision at the end of April in the usual way. Since that time these have been exposed to the air and thus should have shown any changes in resistance quite as noticeably as the resistances at the National Bureau of Standards in Washington, since the latter were immersed in oil. However, it was found that the variations of resistance were less than one part in 100,000, and that the variations of resistance due to the effect of moisture on the shellac, if existing at all in Charlottenburg, remained very small. It was pointed out, however, that the method of construction in which the resistance wire is wound on lacquered wooden spools is unsuitable, and for this reason, resistances of this type are not given certificates as precision resistances by the Reichsanstalt. There is, however, a gradual increase in resistance during a long period of time, which has nothing whatever to do with the climatic conditions. The authors do not approve of the suggestions made by Messrs. Rosa and Babcock that the resistance coils be coated with paraffine or enclosed in a glass tube. The use of paraffine insulation has been abandoned by the Reichsanstalt in order that the coils may be placed in oil, as this permits accurate determination and control of the temperature of the coils. —*Abstracted from the Electrician (London), August* 2.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

National Alternating-Current-Direct-Current Air-Brake Apparatus.

For service on single-phase electric railway cars and for such roads as operate their cars on both single-phase alternating-current circuits and direct-current circuits alternately, the National Brake and Electric Company, Milwaukee, Wis., has developed and perfected a class of air-brake apparatus that compares most favorably in all respects with its widely known direct-current air-brake equipment.

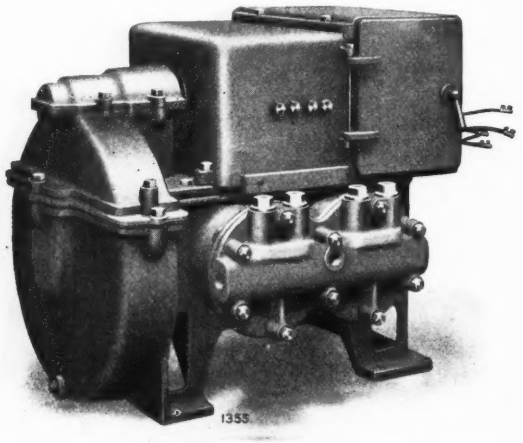


FIG. 1.—NATIONAL ALTERNATING-CURRENT-DIRECT-CURRENT MOTOR COMPRESSOR.

On account of the exacting conditions of service required by modern high-speed single-phase railway operation, the air-brake apparatus for same must be highly efficient, absolutely reliable and free from breakdown at all times.

The alternating-current-direct-current type of motor compressor manufactured by the National Brake and Electric Company is the result of years of serious study, careful experimental work and a thorough and intimate knowledge of the electric railway braking art in its present-day state of perfection.

The compressor in general appearance closely resembles the National standard direct-current machine, and as may be readily seen by referring to Fig. 1, is also of the entirely closed type. The motor and compressor are two separate and distinct units except that the motor bearing at the pinion end of the motor base forms a cover for the upper part of the gear. When assembled these two parts form a most compact and rigid compressor unit. Either one may be replaced without in any way interfering with the successful operation of the other. The simplicity of design and construction, as well as the accessibility of all parts likely to need attention, are illustrated in Fig. 2. The compressor and motor are separated by a one-half-inch air space which carries off the heat radiated by the compressor and thus prevents the motor from becoming heated by the same. The separate cover required by this method of construction strengthens and braces the compressor casing.

The crank chamber and gear case are cast in one piece, which makes a more rigid unit, reduces the number of loose parts and permits the machine to be inspected or dismantled without removing the oil. The crank shaft is fitted with a third bearing in the centre which strengthens it at its weakest point, eliminates all tendency to fracture at the centre and makes the operation of the compressor quieter with greater freedom from vibration than is the case with two-bearing compressors. Removal of the crank shaft and gear is accomplished by lifting them straight out of the crank chamber, it being unnecessary to first remove the gear from the shaft. This feature enables the compressor to be dismantled and reassembled in a shorter space of time than is the case where the gear must be removed from the shaft. The compressor is a standard two-cylinder, single-action type with trunk pistons. The piston rings are the Dunbar type, which this company adopted as its standard eight years ago. The sections of the rings are very carefully assembled by hand and the completed ring is then accurately ground. Each piston is fitted with one piston ring. The piston wrist pin on which the tail end of the connecting rod works is of steel, hardened and ground true; it is pressed into position and rigidly secured so that it is impossible for it to work loose. The connecting rod head is connected to the body of the rod by means of a hinge and a hinged eye-bolt provided with lock nuts and a split pin. The special advantage of this method of construction is that there is only one bolt to adjust or slacken as the case may be; and all possible tendency to loosen up

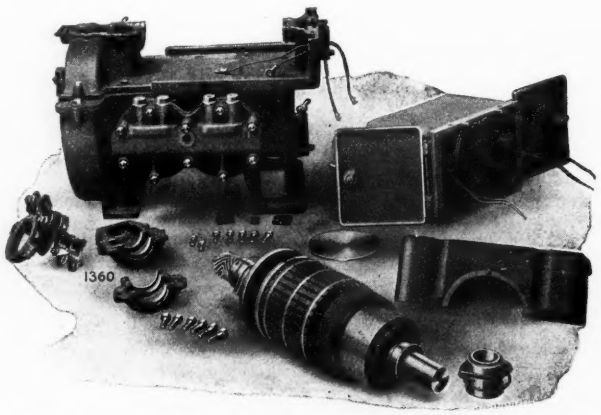


FIG. 2.—ALTERNATING-CURRENT-DIRECT-CURRENT COMPRESSOR PARTLY DISMANTLED.

under the continual reciprocating strains is eliminated.

The valve head is constructed with the discharge valve toward the centre and the suction valve toward the outside of the head. The discharge pipe runs straight out from the valve head to the main reservoir, thus dispensing with the necessity of attaching elbows, etc. The suction has two openings, one on each side of the valve head; either or both can be used. The suction openings are equipped with straining screens of such design and closeness of mesh that all dust and foreign matter is thoroughly entrained before the air reaches the cylinders. The valves are of a type which have been used in standard small air-compressor service for ten years, and have given most excellent satisfaction.

The suction and discharge valves are of the tubular type turned from solid stock and are perfectly interchangeable provided the seats have worn equally. They are seated by gravity aided by air pressure; no spring or auxiliary device being required.

The gear and pinion are a standard herring-bone pattern with finely cut teeth. The gear is of open-hearth cast steel and the pinion of high carbon steel. Both gear and pinion are made in halves and riveted together. The teeth are cut with the greatest accuracy on gear-cutting machines of special design for this purpose. Both gear and pinion are carried on their respective shafts by a taper fit and are further clamped with lock nuts to facilitate their removal when required. The lower half of the motor magnet frame is a steel casting which also carries the bearings and forms a cover for the upper half of the gear. Such construction possesses the advantages of insuring a permanent alignment of all parts and the accurate replacement of the armature when it must be removed.

An oil deflector is provided just inside of the pinion end of the shaft so as to prevent the oil from the gear and pinion creeping into the armature bearing and damaging the insulation of the motor. An overflow device into the crank chamber is also added to the armature bearing at the pinion end to maintain the oil level constant even though some oil may work over past the deflector.

The motor is of the four-pole commutator type with two consequent poles, and is designed for operation on voltages ranging from 500 to 600 volts direct-current circuits, and on voltages ranging from 280 to 340 volts alternating-current, twenty-five-cycle, single-phase circuits. The motor has two distinct field-windings, one for alternating current and one for direct current. Laminated sheet steel pole pieces are used. The pole faces are provided with a compensating winding, which consists of four separate coils, which are short-circuited upon themselves.

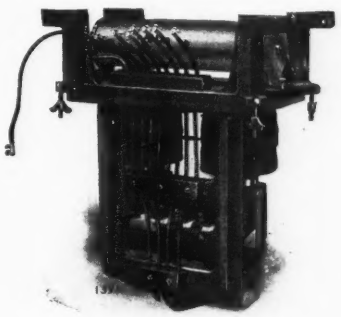


FIG. 3.—RELAY WITHOUT COVER.

The motor frame consists of three parts, the motor base, the magnet frame and the motor cover. The motor cover is bolted to both the magnet frame and motor base. The magnet frame is bolted to the motor base and held in position by four cap screws, and is adjusted centrally with the armature, in regards to its vertical heights, by means of shims, and laterally by means of adjusting set screws.

The armature is removed by taking off the motor cover and then removing the

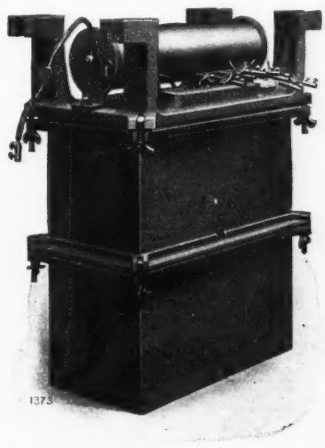


FIG. 4.—COMPLETE RELAY FOR NATIONAL ALTERNATING-CURRENT-DIRECT-CURRENT COMPRESSOR.

bearing cap and cap screws holding the magnet frame to the motor base, and then lifting the magnet frame and armature away from the base. The armature can then be taken out of the magnet frame with ease. Figure 2 shows the compressor partly dismantled, and shows the armature removed from the magnet frame.

The field coils are removed by first removing the armature and then taking out the four cap screws that hold the pole piece on to the magnet frame. The pole piece can then be pushed in toward the centre line of the shaft far enough so that the field coil can be removed. This can be done without disconnecting the compensating winding, as the latter is flexible and can be bent as the pole is pushed inward or back into place. So long as the adjusting shims and set screws are not disturbed the magnet frame can be put back into its original position without any further adjustment.

The commutator is of high commercial quality hard-drawn lake copper, well proportioned and well insulated, with a liberal wearing depth and is designed for severe service.

The brush gear is of the same distinctive construction as that used on the National direct-current compressors, and differs from same mainly in the manner of fastening and the number of brushes. The brush gear proper is securely fastened to a cast-iron yoke made in two halves, which is secured in a groove running entirely around a projection of the armature bearing at the commutator end of the motor. Two sets of brush-holders of two brushes each are used. The holders are fitted with an improved spring tension device which is constant over a very wide range of variation and capable of an easy and correct adjustment. The very liberal insulation of this brush gear gives it a maximum protection against insulation troubles, as may be seen by the fact that the external leakage surface of same is one and one-quarter inches.

The inspection of the armature, commutator and brushes is rendered an easy and quick process by means of the inspection doors at the sides of the motor casing.

The compressor is started by throwing it directly on the full voltage, either alternating current or direct current. A relay is provided for automatically making the connections for running the motor either on alternating or direct-current circuits, and is shown in Figs. 3 and 4. When the direct-current circuit is closed the necessary connections for direct-current operation are made by the solenoids of the relay attracting plungers to which are secured the contact pieces. When operating on the alternating-current circuit these solenoids are not in circuit and the contact carrier drops by its own weight and makes the necessary connections for operating on alternating current. The relay is entirely enclosed and is, therefore, protected from the elements. A diagram of connections is supplied with each

compressor and relay, and the leads are all tagged so that no wrong connections need be made.

The compressor is suspended in a cradle under the car body. This method of suspension allows the entire pump to be exposed to the cooling effect of the air at all times, and none of the parts of the suspension cradle obstructs the access to all parts of the compressor. The relay is mounted under the car body with the compressor.

The capacity of the National alternating-current-direct-current type of compressor is twenty-five cubic feet of free air per minute.

The standard National type "N" oil pneumatic governor is furnished in connection with the National alternating-current-direct-current air-brake equipments, and will operate equally as well on either direct or alternating-current circuits.

The National Brake and Electric Company has recently furnished thirteen alternating-current-direct-current straight air-brake equipments complete with compressors described in this article to the Milwaukee Electric Railway and Light Company, Milwaukee, Wis., for service on its new interurban lines.

Cutler-Hammer Lifting Magnets

For several years the Cutler-Hammer Clutch Company, Milwaukee, Wis., has been quietly designing and experimenting with magnetic clutches and lifting magnets, and so successful has been its work that it now announces its readiness to fill orders for lifting magnets. These can be furnished in any size from a ten-inch magnet for lifting plates, rails, small castings, etc., up to a fifty or fifty-two-inch magnet designed for handling pig iron, scrap, and capable of lifting a ten-ton "skull-cracker."

The Cutler-Hammer lifting magnets are designed by engineers who for years have devoted themselves to problems involving electric and magnetic control. Among the first to order a Cutler-Hammer magnet was the Carnegie Steel Company, for its Donora works. The fifty-two-inch magnet built to this company's order was completed some six months ago, and after being subjected to severe tests was accepted and has been in continuous and satisfactory use ever since. Recently this same concern placed a second order for a similar magnet.

The general appearance of the Cutler-Hammer magnets is shown in the accompanying illustrations. Fig. 2 shows a magnet lifting a Bliss car-lighting generator weighing 800 pounds. Fig. 1 shows a magnet handling steel stampings. Fig. 3 shows a ten-inch magnet lifting three tank heads.

A fifty-inch Cutler-Hammer magnet weighs about 5,000 pounds. It consists of a hollow steel casting, in which the magnetizing coil is placed. The coil is carefully built up of alternate layers of copper and asbestos, and is insulated from the cast-steel frame by thick sheets of mica. No combustible material of any kind is used, hence there is no danger of the magnet being damaged if by accident it should be left in circuit over night. This has actually happened to a magnet of this type. Under test the coils of these magnets have been heated to 470 degrees Fahrenheit without injury.

FIG. 1.—MAGNET LIFTING STEEL STAMPINGS.

The magnet frame is corrugated. This form of construction serves two useful purposes: It provides a greater surface for heat radiation, and at the same time forms niches that protect from injury the heads of the through bolts which fasten the removable pole piece to the magnet frame.

The important consideration of heat radiation is further aided by the simple expedient of casting the magnet frame with a central aperture, through which air may freely circulate.

Another feature of particular importance in connection with the Cutler-Hammer magnets is the use of an auxiliary pole piece. Lifting magnets designed for use with pig iron, scrap, etc., are made concave on the under side, because this form is best for handling large

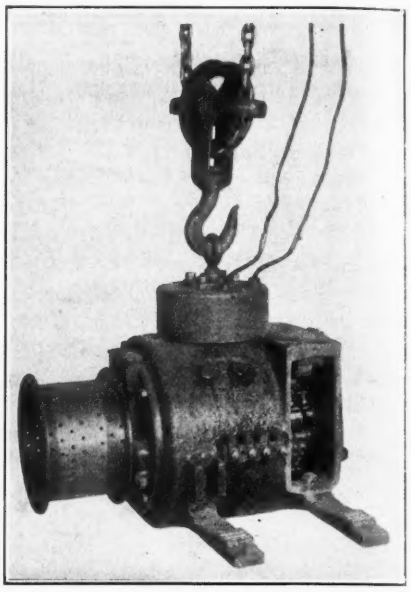


FIG. 2.—MAGNET LIFTING CAR LIGHTING GENERATOR.

numbers of irregularly shaped pieces of metal at a small lift. When, however, the load consists of one or two large objects with plane surfaces, this concavity becomes objectionable, since an air-gap intervenes between the inner pole and the object to be lifted. The central aperture in the Cutler-Hammer magnets makes it possible to convert them in a few minutes from concave-faced magnets to magnets adapted to handling large masses of metal with plane surfaces. This is accomplished

FIG. 3.—MAGNET LIFTING TANK HEADS.

by inserting in the central aperture an auxiliary pole piece so proportioned as to extend the inner pole downward to the level of the outer pole, thus eliminating the air-gap and insuring intimate contact

of both poles with the object to be lifted. A structural feature of importance is the removable pole-shoe bolted to the under side of the magnets. The pole-shoe is subjected to the greatest wear and tear, and the advantage of having it readily renewable is obvious. The use of through bolts instead of cap screws makes it easy to remove the pole-shoe and replace it without in any way destroying the utility of the magnet frame.

Wireless Telegraph Advance.

Consul Thomas H. Norton, of Chemnitz, reports that the Slaby-Arco system of wireless telegraphy, which is the official German system, is making rapid progress not only within but outside the Empire, the present status being:

The number of stations equipped with apparatus of this system is now 641, or forty-one per cent of the entire list of existing wireless telegraphic stations, numbering 1,550. These have all been installed by one Berlin company, which controls a variety of patents in the leading countries on machines and accessories. These 641 stations are scattered over the territory or vessels of thirty-one different countries. Of these some 174 are located on land. They usually command a radius of 125 miles. In several cases this is extended to 310, 435, or even greater distances. Germany's own quota is thirty-six, mostly located on the coasts of the Baltic and the North Sea. It includes the great experimental station at Nauen, which commands a radius of 1,860 miles. In the United States are twenty stations, including Fire Island, Washington, New Orleans, San Francisco and San Juan, P. R. Russia has seventeen stations. That of Vladivostok is the most important, commanding a range of 620 miles. Austria-Hungary has ten stations; Denmark and Spain, each seven; Holland, six (that of Scheveningen reaches 435 miles); Norway and Sweden, each five, etc.

In non-European lands the system has four stations in Argentina, six in Brazil, five in China, eight in Cuba (that of Habana commanding 930 miles); six in Mexico, two in the Philippines, one in the Sandwich Islands (at Honolulu). The majority of these land stations are government property and under the control of the postal, naval, or light-house services.

Most of the installations are on ocean vessels. Of these twenty-two are on Dutch and German steamers, while 389 are on war ships. They include vessels of the following nationalities: German, 140; Russian, 126; American, forty-three; Swedish, nineteen; Austrian, seventeen; Dutch, ten; Norwegian, eight; Argentinian, six; Danish, five; Brazilian, five; Spanish, five; Greek, three and Indian, two.

Fifty-four mobile military stations have been installed in several countries, more particularly in Germany, fourteen; in America, eight; in China, five; in England four, and in Austria-Hungary, four.

In France, Great Britain and Italy the German system is evidently unable to meet the competition of the strongly intrenched systems under local control. In the United States, despite the active competition of the DeForest, Fessenden, Stone, and other systems, it is apparently able to secure a fair share of the installations. The unusual degree of enterprise exhibited by German manufacturers in this special field is by no means in advance of their efforts to secure the lion's share in several other branches of applied electricity.

The Westinghouse Officials.

While commenting upon the excellent annual report of the Westinghouse Electric and Manufacturing Company, a well-known local financier remarked:

"One of the most important factors that has brought about the phenomenal business records of the company within the last year is the perfect organization which dominates all departments. It must be extremely gratifying to Mr. Westinghouse, whose business sagacity and foresight brought this about, and it can not help being pleasing to the stockholders to know that their property is under such an efficient management.

"E. M. Herr, the chief executive under Mr. Westinghouse, has had exceptional experience as an engineer and manufacturer. He was for a time the successful head of the locomotive department of the Northern Pacific Railroad, where he showed great tact in the management of men and won a national reputation for his expert skill in the construction and operation of locomotives. In 1898 he became vice-president and general manager of the Westinghouse Air-Brake Company, and it was his remarkable record in that position which undoubtedly prompted Mr. Westinghouse to place Mr. Herr in charge of the electric company at a time when his qualities were quite essential to its success. Mr. Herr became vice-president of the electric company in 1905 and his connection has proved most effective in improving the affairs of the company.

"L. A. Osborne, the second vice-president of the company, in charge of the engineering and commercial departments, is a remarkable young man, who, though he is but thirty-five years old, has demonstrated during his career with the company an engineering skill as well as a capacity for management which place him among the leading men of the industrial development of this country. He is familiar with every detail of the company's engineering and commercial work, and since Mr. Westinghouse, a year ago, placed him in the important position which he now occupies, he has proved a great success.

"In the engineering department, the leading men are B. G. Lamme, C. F. Scott, H. P. Davis, N. W. Storer and others, all known to the electrical profession the world over for their valuable contributions to the great achievements in the electrical industry during the last twenty years. To them belongs the credit for the development of the single-phase alternating-current railway motor and the many details essential to its operation, an achievement which makes the Westinghouse company one of the most important factors in the modern electrification of railroads.

"To these men also belongs the credit for the product of the Westinghouse company having gained a world-wide reputation for electrical excellence and perfect mechanical construction."

Centennial of Fulton's First Steamboat.

One hundred and thirty engineers of the Robert Fulton Association of the National Association of Stationery Engineers sat down to a banquet on the evening of August 11, at King's restaurant, Chicago, Ill. The occasion for the banquet and attendant speeches was the centennial of Robert Fulton's successful run of the first steamboat a hundred years ago, August 11, 1807, when the diminutive craft "Clermont" paddled down the Hudson river.

Speakers of the evening dwelt upon Fulton's work, hailing his gift to the world as one of the greatest in history.

Royal D. Tomlinson, ex-president of the National Association and supervising operating engineer, and condenser expert for Allis-Chalmers Company, responded to the toast "Engineers Then and Now."

John W. Lane, editor of the *National Engineer*, spoke on "Robert Fulton." George N. Carmen, director of the Lewis Institute, responded to "One Hundred Years of Steam," and Charles W. Naylor, chief engineer for Marshall Field & Company, had for his subject "A Look Into the Future."

Current Electrical News

DOMESTIC AND EXPORT.

IOWA ELECTRIC ROAD TO ISSUE BONDS—The stockholders of the Marengo & Oskaloosa Interurban met recently at the company's offices in Marengo, Iowa, to consider the matter of authorizing the issue of coupon bonds of the company to the amount of $18,500 per mile, to enable the prompt financing of the road, whenever the necessary bonus shall be ready. There was a large attendance and by a practically unanimous vote, the bond issue, totaling $1,600,000 was ordered.

KNOXVILLE POWER COMPANY—The Knoxville Power Company, Knoxville, Tenn., is to be reorganized and a contract let for building a dam across the Little Tennessee river. This dam will be about 500 feet long and eighty feet high. This company owns several thousand acres of land for the reservoir to be created by the dam, the dam site, and the land through which the canal will pass to the power-plant site. It is probable that $2,000,000 will be invested in the undertaking.

NEW POWER PLANT—A third power plant is to be installed in the Black Hills, South Dakota. The latest company to enter this field is the Dakota Power Company, composed of eastern capitalists who have secured an option on some ground on Rapid creek which they will harness at a point about two miles below Placerville, one of the oldest placer mining camps in the hills. The plant will be able to generate 10,000 horse-power, and will be the only power plant in the Southern Hills. It will furnish power to Rapid City and to the surrounding small towns.

ELECTRIC ROAD SEEKS TO ENTER NEW YORK CITY—Arthur P. Heinze, vice-president of the United Copper Company and brother of F. Augustus Heinze, has been elected a director of the South Shore Traction Company, of Long Island. This company has obtained a franchise from the town board and highway commissioners of Hempstead, L. I., and now maintains that it has an uninterrupted chain of franchises from Patchogue to the New York city line. The company plans to enter New York by way of the proposed Fifty-ninth street bridge. Among those interested in the company are F. D. Kilburn, former superintendent of banks; Paul T. Brady, a director of the Westinghouse Electric and Manufacturing Company; James T. Wood, president of the Riverside Bank, and William T. Young, president of the Bank of Suffolk County.

LARGE MICHIGAN MORTGAGE FILED—The Indiana & Michigan Electric Company, composed of the Chapin dam corporations, merged recently, has filed in the office of Register of Deeds Dodd in St. Joseph, Mich., two mortgages aggregating $7,900,000. The new York Trust Company, of New York, is mortgagee. The first mortgage is for $7,000,000, running for fifty years and drawing five per cent interest in gold. The second incumbrance is for $900,000, at six per cent, and running for twenty years. Within a few months the company also plans to commence the building of an electric line between Buchanan and Niles. The right-of-way has been secured and it was thought that the work would be done by the Southern Michigan Railway Company, but it was declared that the Chapin interests will put in the spur. The Southern Michigan company has contracted with the Indiana & Michigan company for power for operating its lines.

NEW CONCERN TO SUPPLY ELECTRICAL ENERGY—A syndicate, in which the Reading Railway, as lessee of the Schuylkill Navigation Company, is interested, has completed plans for the erection of a 100,000-horse-power electric power plant on the bank of the canal at Manayunk, Pa. Work is to be started within a month. It is the intention of the syndicate to furnish electric power and light to factories and trolley companies, as well as supply towns near Manayunk. The building, which will be erected on the west side of the navigation company's canal, a short distance above the intercounty bridge over the Schuylkill, will cost more than $100,000. Power will be generated by the water course known as the "wasteway," out of which surplus water taken from the canal flows. The plant will be 100 feet square, one story in height and will be erected on property belonging to the navigation company. Detail plans of this plant are in the possession of E. F. Smith, general manager of the navigation company, who has offices in the Reading Terminal. The contract has been let to a Reading builder and the plant is to be ready to run within two years. The navigation company intends to replace the old west retaining wall, known as the "burbank," at once, in order to insure the new plant against loss of water. The new retaining wall, which will extend from the intake at the Flat Rock end of the canal to the end of the short level below the upper locks, will be made of reinforced concrete. It will be more than 500 feet long, twenty to twenty-five feet high and six feet wide. Work on this wall will be commenced next month.

NEW JERSEY RAILWAY MERGER—Announcement is made of the merger of the various street railway companies controlled by the Public Service Corporation of New Jersey into one company, to be known as the Public Service Street Railway Company, with a capital stock of $38,000,000. The Public Service Corporation will still remain in existence and will control the Public Service Street Railway Company. There are to be 380,000 shares of stock of the new company, par value $100 each. Every dollar of this is to be issued at once with the approval of a majority of the stockholders of the North Jersey, the Jersey City, the Hoboken & Paterson and the United Street Railway Company of Central Jersey. All of the stock is to be exchanged for $39,000,000 of the merged companies; $37,000,000, par value, of this was acquired by the Public Service Corporation for about $14,000,000, par value, perpetual interest bearing certificates, supposed to be secured by a general pledge of all the securities so acquired. Under the new plan it is proposed indirectly to restore the face value of the stocks of the various companies acquired in exchange for the $14,000,000 in certificates, which have a market value of less than $10,000,000. It is intimated that the "perpetual" certificates are to be exchanged for five per cent bonds. There will be eleven directors of the new company, as follows: Thomas O. Barr, of Orange, N. J.; John J. Burleigh, of Merchantville, N. J.; Albert B. Carlton, of Elizabeth, N. J.; Walton Clark, of Philadelphia; Mark T. Cox, of East Orange, N. J.; Anthony R. Kuser, of Bernardsville, N. J.; Lewis Lillie, of Haverford, Penn.; Randall Morgan, of Philadelphia; Thomas N. McCarter, of Rumson, N. J.; Uzal H. McCarter, of Rumson, N. J., and Charles A. Sterling, of East Orange, N. J. The first officers of the new company, who will hold office for the first year, or until others are chosen, are: president, Thomas N. McCarter; vice-presidents, Charles A. Sterling, Albert B. Carlton, John J. Burleigh; secretary, Frederick Evans, of New York; assistant secretary, Harry C. Stevenson, of Newark; treasurer, James P. Dusenberry, Newark; assistant treasurer, Robert D. Miller, Jersey City. The principal offices of the new company will be as now, in the Prudential Building, Newark. The stocks of the various companies are to be converted into stock of the new company, as follows: The stock of the North Jersey Street Railway Company, issued and outstanding, amounting to $15,000,000, consisting of 150,000 shares of the par value of $100 each, shall be convertible into 150,000 shares of the new company's stock. The stock of the Jersey City, Hoboken & Paterson Street Railway Company, issued and outstanding, amounting to $20,000,000, consisting of 200,000 shares of the par value of $100 each, shall be convertible into 200,000 shares of the capital stock of the new concern. The stock of the United Street Railway Company of Central Jersey, issued and outstanding, amounting to $4,000,000, consisting of 40,000 shares of par value of $100 each, shall be convertible into 30,000 shares of the new stock, and the holders of the United Street Railway stock shall receive three shares of the new stock for four of the old. All the stocks are to be transferred at the Fidelity Trust Company's office. It is said that this is the first move toward a merger of all the public utility companies of Newark with the Public Service Corporation. At present the corporation only leases the electric lighting and gas plants.

ELECTRIC RAILWAYS.

GREAT BARRINGTON, MASS.—The selectmen have signed the franchise granting the Berkshire street railway the right to carry freight and express through the village.

CHEYENNE, WYO.—The city council has passed on first reading an ordinance granting to W. J. Barker, of Denver, a street railway franchise. The council also revoked the street railway franchise granted to Eugene Sweeney, of Denver.

SHREVEPORT, LA.—Promoters of a new subdivision of Shreveport announce that they are planning to ask for a franchise at the next meeting of the city council to construct a new electric car line to cover much of the country outside the city.

SANTA ANA, CAL.—The Port Orange Electric Railroad Company has made the people of Tustin a proposition to run its line from Port Orange to this city by way of Tustin. The offer has been accepted and a right of way from Tustin to Santa Ana will be secured.

OWENSBORO, KY.—The electric railway from this city to Calhoun, Ky., for which the right of way over the streets of this city has been asked, will be built by local capital. Judge Wilfred Carico, attorney for the company, states that it is purely a home enterprise.

FAIRMONT, W. VA.—The grading for the new street-car line between Mannington and Fairmont has been practically completed by the F. H. Blodgett Company, general contractors, and Contractor L. G. Hallock has started the masonry work, which will include ten or twelve arches and bridges.

VALDOSTA, GA.—The work of grading a right of way for the trolley line from Quitman to this city *via* Blue Springs is well under way. Grading has been completed two miles out of Quitman and has been started at Blue Springs. The ultimate aim is to connect Valdosta and Thomasville.

CLINTON, ILL.—Plans have been completed for the erection of a new interurban station in this city. Work will be commenced soon. The new station to be constructed by the Illinois Traction System will be modern in every way. The structure will be forty by 120 feet and will be of ornamental brick with a concrete roof.

NEW YORK, N. Y.—The public service commission has granted the application of the Nassau Electric Railway, a subsidiary of the Brooklyn Rapid Transit Company, for permission to lay tracks in Livingston street and in Lafayette avenue, borough of Brooklyn, in accordance with the terms of the franchise granted recently by the board of estimate.

HARTFORD, CT.—A local excavating firm has begun digging for the concrete water main that the Consolidated Railway Company is to connect from the river with its present power plant on Commerce street. The main will supply water for the new condensers and engines which will be installed as part of the scheme of improvements, which will cost in the neighborhood of $250,000.

PINE BLUFF, ARK.—W. H. Langford, vice-president of the Little Rock & Pine Bluff Traction Company, which was chartered recently with a capital stock of $1,000,000 for the purpose of constructing an electric interurban line between Pine Bluff and Little Rock, has received a letter from J. J. Fiske, of Chicago, president of the company, stating that the necessary money for constructing the interurban had been secured. Surveys will begin at once.

PORTLAND, ORE.—Plans have been practically completed for the erection of a $1,000,000 power plant on the head waters of the Sandy river, a few miles east of this city, to furnish electric power for an interurban line the United Railways is building between Portland and Salem. Negotiations are now being conducted with eastern capitalists for financing the construction of the plant.

COLORADO SPRINGS, COLO.—The Colorado Springs and eastern promoters who held a ten-day option on the street-car franchise in this city owned by Wallace E. Hooke, have secured a thirty-day refusal on the franchise and are negotiating with parties in Chicago and New York with a view to taking up the option. They say that if the franchise is purchased by the syndicate, active operations will begin at once on the construction of another street-car system in Colorado Springs.

LA JUNTA, COLO.—Articles of incorporation of the Arkansas Valley Traction Company have been recorded. The incorporators are E. S. Alnutt, J. E. Gauger, H. W. Potter, R. G. Dalton and J. B. Pearce. The capital stock is $150,000. Surveying for the line has been begun. It will run on the south side of the county road from La Junta to Swink and will continue to Rocky Ford. The company proposes to begin work within a year and must have cars in operation before eighteen months.

COLUMBUS, OHIO—The Youngstown, Alliance & Akron Electric Railway has been incorporated. It will run through Mahoning, Columbiana, Stark, Portage and Summit counties. Capital stock is $10,000. Incorporators are: Henry Shaffer, V. K. McMullin, E. H. Brosius, Hugh Bleakley and R. S. Kaylor. Its headquarters are at Alliance. Right of way between Alliance and Akron has already been secured and work is to begin at once to secure rights of way from Alliance to Youngstown. It is in fact for this purpose that the capital stock of $10,000 is to be used; as soon as preliminary work is completed the stock will be increased to $2,000,000.

DAVENPORT, IOWA—The Manchester-Davenport Interurban Company is to be incorporated with a capital stock of $15,000, all of which will be paid in. This is the proposed line discussed several times at the Commercial Club and which resulted in an organization being formed with these officers: president, George T. Baker, of Davenport; vice-president, J. R. Voorhees, of Monticello; secretary, F. W. Rank, of Moline; treasurer, T. F. Halligan, of Davenport. The company is organized for the sole purpose of making the preliminary surveys between Davenport and Manchester and the capital stock will be composed of the money that has been raised in the various cities.

LEWISTON, IDA.—Upon his return from the East, E. H. Libby, who recently resigned as president and manager of the Lewiston-Clarkston Company, will begin the promotion of an electric line from the Walla Walla country in eastern Washington to Clarkston and Lewiston, where connection will be made with the Spokane & Inland, which line already has its survey completed into North Lewiston. A preliminary survey for the line from Walla Walla to Clarkston was made some time ago, the line running through the rich Dayton and Pomeroy country. Among those interested in the company organized to build the Lewiston line are Miles Moore, a Walla Walla banker, and A. B. Campbell, a mining capitalist of Spokane.

GREELEY, COLO.—The county commissioners have decided to grant a franchise to the Interurban Construction Company, composed of many prominent Denver men, with E. N. Reaser, of Denver, as its president. Mr. Reaser said that the road would be constructed parallel to the Union Pacific tracks along the Greeley and Denver road and that the survey would start at once so that the road could be built as quickly as possible. The commissioners in the past year have granted many franchises to other companies who did not accomplish any work. They granted this franchise on the condition that if the new company accepts the franchise in thirty days it is to put up a bond of $25,000 as a guarantee that it will complete the road in two years and start work within six months from the date of the acceptance of the franchise or forfeit its bond.

SAN FRANCISCO, CAL.—Pasadena, Los Angeles and possibly eastern capitalists are making an effort to enter San Francisco with a new street-car company in opposition to the United Railroads. The basis of their plan is a charter amendment permitting them to operate on the United Railroads' own lines. John J. Egan, a retired army officer, is in San Francisco in the interest of the plan. Egan and his assistants will endeavor to obtain popular sanction for a special election within sixty days for the purpose of voting on the proposed amendment. The object of the petition is to obtain the signatures of 10,000 registered voters, as required by law, attached to the call for the special vote on the section of the charter as it will stand when amended. The proposition which he places before the voters is to have that section of the city's charter in relation to franchises changed to read so that an opposition street railway may be allowed to run its cars thirty-one blocks instead of twelve over tracks covered by franchises held by another company. The charter now permits the lesser figure.

ELECTRIC LIGHTING.

COVINGTON, IND.—The plant of the Covington Light and Water Company was damaged by fire on August 7 to the extent of $2,500.

VALLEJO, CAL.—The town of Cordelia, situated a few miles from Vallejo, is to be lighted with current supplied by the Bay Counties Power Company.

RICHMOND, IND.—New machinery and other equipment for Richmond's municipal electric lighting and power plant, costing $29,347, have been placed in position.

SUNNYVALE, CAL.—The United Gas and Electric Company is preparing to light the streets of the town. Poles and wires are being installed. About twenty arc lights will be used.

WINONA, MINN.—The Winona Railway and Light Company has decided upon betterments to its plant that will cost $17,000. The improvements will include some double-tracking and new apparatus.

ST. JOSEPH, MO.—W. C. Stewart, city electrician, has recommended the location of thirty new street lamps. A new dynamo was recently installed at the city electric lighting plant, making it possible to increase the number of lamps.

STEUBENVILLE, OHIO—The county commissioners have granted a twenty-five-year franchise to H. T. Roe, of Dillonvale, to erect electric light wires and poles along the Dillonvale and Mount Pleasant road, between White Bridge and Mount Pleasant.

ROCKY FORD, COLO.—The city authorities are contemplating a change in the system of street lighting. At present the lights are furnished by the local light company, but if present plans are carried out an electric lighting equipment will be installed at the city water plant.

YOUNGSTOWN, OHIO—Construction of the round-house and the lighting plant to be built by the Pennsylvania Railroad at Mahoningtown, Pa., will be started September 1. Material for the improvements is now being received. The cost of the work will aggregate $250,000.

DOVER, DEL.—Articles of incorporation have been filed for the Juneau Water, Light and Power Company, of New York city, to build, maintain and operate plants for the control and use of water and to distribute the same for power of all kinds. The incorporators are: J. Herbert Miller, E. W. Waybright, of New York city, and I. M. Harvey, of Brooklyn. The capital stock is $4,000,000.

SAN FRANCISCO, CAL.—The Southern Pacific is planning to erect an electric-power plant at Dunsmuir, to be used in furnishing power for the operation of its railway repair shops. Application has been made for permission to take 5,000 miners' inches of water from the Sacramento river at Dunsmuir, to furnish the water power necessary to operate the dynamos.

ROCKAWAY, N. J.—Arrangements are being made to connect the electric light system in Rockaway with the power plant of the Dover Electric Light Company, the controlling interest of both concerns being owned by one stockholder. It is said the connecting wires will be strung on the trolley poles between Dover and Rockaway, and that the new service will begin about September 1.

MILWAUKEE, WIS.—The specifications for the gas-producer portion of the municipal electric lighting plant have been printed and delivered to the board of public works. They provide for four units. The printed copies of the specifications for the four engines are expected to be published. It is planned to give manufacturers thirty days in which to figure on supplying this machinery to the city.

DETROIT, MICH.—Trenton will sell its municipal lighting plant to the Detroit Edison Company. The company is to furnish lights at $65 per year for each arc, to burn all night. The company is also to buy the present plant for $8,000. The principal reason for selling the plant was a recent decision of the Supreme Court ordering the village council to remove the plant so that it would not encroach on St. Joseph's avenue.

ROCKWELL CITY, IOWA—The electric light and power plant of the Rockwell City Electric Light and Power Company has been purchased by F. S. Moore, formerly an electrical inspector of Terre Haute, Ind., and he will take charge of it September 4. He expects to rebuild the lines and make other extensive improvements. Mr. Moore owns and operates the Oquawka, Ill., electric light plant, but will make Rockwell City his headquarters.

COVINGTON, OHIO—The board of council has accepted the proposition of the Union Light, Heat and Power Company to supply 450 arc lights for street lighting purposes at $65 per lamp per year, with a $10 rebate if the contract is renewed for another year. The present rate is $65, so that, under the new contract, the city will save about $4,500 a year. With the approval of this contract the recently annexed territory, formerly known as Central Covington, will have fifty-three arc lights for its streets.

ASHLAND, WIS.—The city council held a special meeting to open and consider bids for the proposed municipal electric light plant. There was only one bid, that of Mr. Ule, a Stevens Point contractor. His was $130,000. The bid was rejected and it was decided to re-advertise. The bid of Mr. Ule was $50,000 in excess of the estimate made last fall by the special committee appointed to investigate and report on the probable cost of building and equipping such a plant, its estimate being $80,000.

BRISTOL, CT.—A special town meeting has renewed the contract with the Bristol & Plainville Tramway Company to light the streets of the town for the next five years. The contract expired this year. The resolution as passed calls for not less than ninety-nine arc lamps of 1,200 candle-power, and the town has the power to order extra lights at an annual rental of $87.50 each, the lamps to be burned from dark to 1 A. M., and from 5 A. M. to daylight. In case of fire at night the street lights are to be lighted.

AMERICUS, GA.—Ground has been broken for an electric plant to be installed in Americus by a company capitalized at a quarter of a million dollars. The surety bond of $25,000 required of the company by the city has been delivered, and active operations will commence immediately. The company will construct and operate for twenty years under contract for which bond is given, an electric street railway system, and likewise furnish the city water and lights for like period. William A. Dodson, of Americus, promoted the enterprise.

PASADENA, CAL.—The report for the first month's operation of the municipal electric light plant shows a saving to the taxpayers of $813.76 in the lighting of streets, fire-houses, city hall, police department and the public library. It is expected that a better showing will be made when the commercial lighting system is installed. Even under the present adverse circumstances, with the plant only about half completed, the total operating and fixed charges of the municipal plant were only $3.31 per arc lamp. At the present time there are installed on streets and alleys, 298 arc lamps and sixty-six thirty-two-candle-power incandescent lamps.

GEARY, S. D.—By a vote of nearly two to one, residents of this place decided in favor of the construction and operation of an electric lighting system and for the completion of the municipal waterworks system, which is in the process of construction. Bonds to the amount of $4,500 were voted. The electric light plant, like the waterworks system, will be owned and operated exclusively by the town. That the electric light system will be a paying investment is assured. The state school for the blind, which is located here, will use the lights to the amount of $600 yearly, and the business men and other residents have agreed to become patrons of the system. The work of constructing the system will be pushed to completion as rapidly as possible.

HOT SPRINGS, ARK.—The council has granted a lighting franchise to the Consumers' Electric Company, represented by Atwood Benton, agent and trustee. Under the terms of the grant the maximum rate which can be charged is seven and one-half cents per kilowatt-hour. The maximum rate charged by the company now in the field is twelve cents. The financial backers of the enterprise are the directors and stockholders of the Webster Gas Engine Company, of Kansas City, Mo., who intend to retain the common stock of the Consumers' company, placing a part of the preferred on the market. The plant is to be located in the eastern part of the city, near Gulpha creek. The franchise stipulates that all portions of the city must be supplied, at the option of consumers, by April 1. Every effort will be made to have the plant in operation by the first of the year in order to take advantage of the winter months. It is estimated that the plant will cost approximately $135,000.

PERSONAL MENTION.

MR. O. T. HUNGERFORD, president of the Dielectric Company of America, Belleville, N. J., is making a trip to Cuba.

MR. BION J. ARNOLD has been retained by W. M. Ivins, special counsel to the public service commission, first district, New York, to assist in preparing for the investigation of the street railways of New York city.

MR. G. A. BROTHERS, who has been for many years manager of the electric light and power station at Hookset, N. H., has accepted a position as general manager of the Hudson electric light and power station at Hudson, Mass.

DR. W. M. HABIRSHAW, the well-known insulated wire manufacturer, returned to New York last week after a thirteen weeks' sojourn abroad. The rest and recreation the doctor experienced have enabled him to return in the best of health.

MR. W. B. MOORE, who has been manager for the Cumberland Telephone Company at Alexandria, La., for several months, has been transferred to Houma. A. B. Hood, formerly of New Iberia, has been appointed to fill the place vacated by Mr. Moore.

MR. E. H. LIBBY has resigned as president of the Lewiston-Clarkston Company, of Lewiston, Ida. He will devote his attention to the marketing of real estate owned by the company and to the new power developments that are being planned for the Lewiston-Clarkson country.

MR. HENRY M. HUXLEY has resigned from the manager's staff of the Worcester district of the American Steel and Wire Company to become assistant general manager of the Duplex Metals Company, manufacturers of Monnot copper-clad wire and sheets. Mr. Huxley will be located at the New York office, 208 Fifth avenue.

MR. RICHARD C. SMITH, formerly of the American Steel and Wire Company and the National Wire Corporation, has been appointed sales agent of the Safety Insulated Wire and Cable Company, to take the place of Mr. Avery P. Eckert resigned. Mr. Smith has appointed as his assistant Mr. R. C. Wilson. These appointments become effective September 1.

MR. GEORGE T. MANSON, general superintendent of the Okonite Company, Limited, returned last week from a tour of the great lakes and a visit in Duluth, Minn. Mr. Manson was accompanied by Mr. Charles E. Trump, president of the Novelty Electric Company, Philadelphia, Pa., and while in Duluth enjoyed a reunion banquet with Messrs. E. B. Baker and George A. French, formerly of the Southern New England Telephone Company, but now engaged in telephone work in the northwest. Mr. Baker is general manager of the Minneapolis Central Telephone Company, with headquarters at Minneapolis, and Mr. French is general manager of the Duluth Telephone Company.

MR. AVERY P. ECKERT has recently been appointed general sales manager of the Duplex Metals Company, sole manufacturer of Monnot metals, with general offices at 208 Fifth avenue, New York city. Mr. Eckert is one of the pioneers in both the manufacturing and selling organizations connected with the wire industry. His first work in the electrical field was with the Metropolitan Telephone Company, now the New York Telephone Company. He was with this company for about six years, and worked in all departments, gaining a wide experience, which has made him very successful in his later connections. After leaving the telephone company Mr. Eckert was associated with the Kerite Wire Company for about three years. He was connected with the Safety Insulated Wire and Cable Company for about fourteen years, acting as sales manager. For several years Mr. Eckert was the secretary of the Electrical Trades Society. As general sales manager of the Duplex Metals Company Mr. Eckert is fitted by experience and temperament to advance the prestige and use of Monnot copper-clad products. The Monnot copper-clad wire is made by the method discovered by J. Ferreol Monnot, and is composed of a steel core and a welded surface of copper of any desired thickness. The Monnot process produces an autogenous union of the metals which are so perfectly welded together in the ingot or billet that the joined metals can be rolled and drawn together as a homogeneous metal. The company's works are at Chester, Pa.

MR. AVERY P. ECKERT.

ELECTRICAL SECURITIES.

For the third consecutive week the stock market has experienced a decline, this time so severe that prices have reached lower points than for many years, and out of all proportion to the real value of the securities involved. While this condition is serious, it loses many of its alarming features when it is realized that at no time has demoralization set in. The fact that the financial interests have been able to sustain such a decline and still hope that the present state of affairs is one of a temporary character only shows the real strength and stability of business interests in general. Business continues good, and while in some quarters there is talk of retrenchment, the indications are that there is little cause for uneasiness. Dividends are in vogue, among others, the following being noted: Terre Haute Traction and Light; semi-annual dividend of $3 per share on the preferred stock, payable September 1. Books closed August 23, and reopen September 2. Kansas City Railway and Light; quarterly dividend of one and one-quarter per cent on the preferred stock, payable September 2. Books closed August 19 and reopen September 3. Galveston Electric; semi-annual dividend of $3 per share on the preferred stock, payable September 3, to stockholders of record August 22. Northern Texas Electric; semi-annual dividend of $3 per share has been declared on the preferred stock, payable September 3, to stockholders of record August 22. Georgia Railway and Electric; quarterly dividend of one and one half per cent on the common stock, payable August 20.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 17.

New York:	*Closing.*
Allis-Chalmers common	6⅛
Allis-Chalmers preferred	18½
Brooklyn Rapid Transit	40⅞
Consolidated Gas	101
General Electric	123½
Interborough-Metropolitan common	10⅛
Interborough-Metropolitan preferred	24½
Kings County Electric	119
Mackay Companies (Postal Telegraph and Cables) common	59
Mackay Companies (Postal Telegraph and Cables) preferred	59
Manhattan Elevated	118
Metropolitan Street Railway	47
New York & New Jersey Telephone	110
Western Union	74½
Westinghouse Manufacturing Company	130

The report of the Allis-Chalmers Company for the fiscal year ended June 30 last will be made public soon. It will be more favorable than the report for the preceding year, although it will not reflect the full benefits that should accrue to the company through extensions and improvements which have added materially to, and diversified the production of the company.

Boston:	*Closing.*
American Telephone and Telegraph	104½
Edison Electric Illuminating	208
Massachusetts Electric	53
New England Telephone	108
Western Telephone and Telegraph preferred	70
Philadelphia:	***Closing.***
Electric Company of America	8¾
Electric Storage Battery common	44
Electric Storage Battery preferred	44
Philadelphia Electric	7¾
Philadelphia Rapid Transit	16⅝
United Gas Improvement	84¾
Chicago:	***Closing.***
Chicago Telephone	105
Chicago Edison Light	140
Metropolitan Elevated preferred	60
National Carbon common	70
National Carbon preferred	110

About $3,000,000 of the new $4,000,000 Chicago Telephone Company stock has been subscribed for. Rights on the new stock are weak at one and one-quarter on selling by stockholders who can not take the new shares.

TELEPHONE AND TELEGRAPH.

CUMBERLAND, MD.—The Chesapeake & Potomac Telephone Company has asked permission to lay a $100,000 conduit system in this city.

COLUMBUS, OHIO—The Swanton Home Telephone Company, of Swanton, Fulton county, has been incorporated by Mathias Lockbribler and others.

RENO, NEV.—The Pacific States Telephone Company has received a new switchboard which will enable it to accommodate 380 new subscribers.

PLAISTOW, N. H.—The New England Telephone Company has a force of men at work putting in new lines to connect Newton and Kingston with the local office.

BURLINGTON, VT.—The New England Telephone and Telegraph Company has changed over its plant at Burlington from the magneto to the common battery system.

LURAY, VA.—The town council of Luray, which for several weeks has been advertising a telephone franchise for sale, has sold it to the Page Valley Telephone Company for $55, with an annual franchise tax of $25.

HOUGHTON, MICH.—The patrons of the Michigan State Telephone Company will now be able to talk to Ontonagon, Greenland, Mass and other points, which hitherto have not been connected directly with Houghton. The line to Rockland has been completed.

HARTSVILLE, TENN.—The switchboard for the Home, the new telephone company which is to operate in Hartsville, has been received. Poles are being hauled and the house to be used for an exchange has been put in shape. A large number of subscribers have been obtained, many citizens of this place being stockholders in the new company.

HOPKINSVILLE, KY.—At a meeting of the representatives of the stockholders of the Cumberland Telephone and Telegraph Company, it was ordered that the headquarters of the company be removed from this city to Louisville, and that the capital stock be increased $200,000. No action was taken regarding the changing of the company shops from Nashville to Louisville.

EDWARDSVILLE, ILL.—The Farmers' & Merchants' Telephone Company, of Highland, has changed hands, and the system is now owned by Philip Baer, of St. Jacob, C. T. Pabst, Michael Matter, A. P. Mosimann, L. O. Kuhnen, H. J. Buchheim and J. N. Stokes, of Highland, all equally interested. The new stockholders have elected A. P. Mosimann, president; H. J. Buchheim, vice-president; and C. T. Pabst, secretary and treasurer. The company already has upward of a hundred instruments installed, and the list of subscribers will be increased as rapidly as possible.

KANKAKEE, ILL.—At the annual meeting of the Eastern Illinois Independent Telephone Company the following officers were elected: President, William Fraser; vice-president, Joseph Speicher; secretary, Jay E. Sherwood; treasurer, T. A. Legris; directors, T. A. Kerr, C. M. McLaughlin, A. J. Vernier, T. A. Legris, J. E. Sherwood, F. W. Gottshall, William Fraser, W. H. Radeke, F. S. Briggs, C. N. King. Although the company is but three years old, over 2,300 subscribers receive service through its telephones.

ROCHESTER, N. Y.—Walter B. Duffy, Harold P. Brewster and Daniel B. Murphy have been appointed a reorganization committee by Mayor Cutler, according to the power given him by the reorganization plan adopted at the meeting of the bondholders' committee of the United States Independent Telephone Company. The duties of the committee, as defined in the second section of the plan, are to "bid in, at the foreclosure sales, at such prices as to them shall seem best, all securities held by the two existing corporations (the United States Independent Telephone Company and the Independent Telephone Securities Company), covered by their respective mortgages."

NEW ORLEANS, LA.—The United Fruit Company is pushing the construction of a series of wireless telegraph stations to give the company direct communication between New Orleans and its fruit sections in Central America. Equipment for the first of these stations, to be erected on Swan Island, 200 miles from Colon and at the meeting point of the Caribbean Sea and the Gulf of Mexico, has been shipped, accompanied by a force of mechanics and electricians to install the apparatus. A similar station will be erected at Cape San Antonio, Cuba, and a station at Southwest Pass will complete the circuit and afford more direct communication with the heretofore inaccessible countries.

AUGUSTA, ME.—A certificate of association has been filed by the Mt. Abram Telephone and Telegraph Company. The purposes of the corporation are the constructing, maintaining and operating of telegraph and telephone lines from some convenient point in Bethel village in the town of Bethel, Oxford county, through the towns of Albany and Glenwood, to some convenient point in the town of Waterford. The capital stock of the corporation is $2,000, of which amount the sum of $275 has been paid in, and the par value of the shares is $5 each. The stock is divided among a large number of subscribers, residents of Bethel and the surrounding section. The president of the corporation is Joseph F. Harrington, of Greenwood, and the treasurer is W. C. Cross, also of that town. The directors are Joseph F. Harrington, of Greenwood; M. H. Harrington, of Greenwood; W. A. Holt, of Greenwood; F. L. Edwards, of Bethel, and G. E. Grover, of Albany.

RICHMOND, VA.—Large increases in its net earnings and surplus for the six months ended June 30 were shown Saturday by the Cumberland Telephone and Telegraph Company in a report on its operations for the first half of this year. The company's gross earnings for June were stated as $482,499, or $31,205 more than those for the corresponding month last year, while its expenses involved $298,183, or $9,685 more than those for June of the previous year, leaving net earnings of $184,316, or $21,520 more than those for June, 1906. Charges and taxes involved $38,026, or $5,739 more than those for June, 1906, leaving a surplus of $146,290, or $15,781 larger than the surplus for June of the previous year. Gross earnings for the six months ended June 30 aggregated $2,886,952, or $251,216 more than those for the first half of last year, while expenses amounted to $1,802,644, or $153,550 more than those for the first six months of 1906, leaving net earnings of $1,084,308, or $97,666 more than those for the first six months of last year. Charges and taxes involved $212,114, or $36,109 more than those for the first half of last year, leaving a surplus of $872,194, or $61,557 more than the surplus at the close of the first half of 1906.

NEW INCORPORATIONS.

HARRISBURG, PA.—Lords Valley Telephone Company, Lords Valley, Pike county. $50,000.

MADISON, WIS.—Prentice Light, Power and Water Company. $3,000. Incorporators: A. F. Zeigler, H. E. Zeigler and Anna Zeigler.

SPRINGFIELD, ILL.—Watseka Telephone Company. To operate a telephone system. $35,000. Incorporators: P. N. H. Munson, M. P. Turner and S. A. Walsh.

LAWTON, OKLA. Lawton Lighting Company. $100,000. Incorporators: C. S. Stephenson, of Lawton; J. E. Stephenson and D. E. Stephenson, of Ansonia, Ohio.

MEQUON, WIS.—The Freistadt & Cedarburg Telephone Company, town of Mequon, Ozaukee county. An amendment increasing its capital from $3,000 to $7,000.

BOSTON, MASS.—New England Engineering and Equipment Company. Electrical and mechanical engineering. $50,000. President and treasurer, W. J. Phinney, Brookline.

MADISON, WIS.—Intercounty Telephone Company, Durand. $8,000. Incorporators: W. H. Gifford, Ward E. Loodell, Phil Fox, N. P. Ward, Edward Will and Charles Winget.

CINCINNATI, OHIO—The Fitzsimmons Telephone Company, of Norwood. $5,000. Incorporators: Harry Burckhardt, James J. Mullaney, George Heeb, Charles Baker and Ferdinand A. Basson.

NASHVILLE, TENN.—South Memphis Light and Traction Company, of Shelby county. $50,000. Incorporators: W. E. Gage, K. D. McKellar, G. W. Edwards, James F. Hunter and W. G. Thomas.

RALEIGH, N. C.—New South Investment Company, of Salisbury. To foster industrial enterprises in the South, build factories, street railways, water, and other power plants. $5,000,000. Stockholders: Cornelius O'Connor and Dix W. Noel, of New York city, and Fred H. Payne, of Williamsport, Pa.

INDUSTRIAL ITEMS.

BURNS & MacDONNELL, Kansas City, Mo., electrical contractor and dealer in electrical supplies, announces its removal from 709 Dwight Building to 823 Scarritt Building, Kansas City.

THE ASBESTOLITH MANUFACTURING COMPANY, 156 Fifth avenue, New York city, will be pleased to send literature devoted to its "Asbestolith" flooring, a sanitary fireproof material.

THE UNITED STATES CARBON COMPANY, New York city, manufacturer of the "Copley-Senior" carbon brushes, has ready for distribution new catalogues and price lists devoted to these brushes and their applications.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has removed its San Francisco offices from the temporary location at 11 Hawthorne street to the Crocker Building, where it will be permanently located.

THE EXCELLO ARC LAMP COMPANY, 24 East Twenty-first street, New York city, has published a list of spare parts for Excello flaming arc lamps. This gives illustrations and dimensions, together with prices of these parts.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 17 Park Place, New York city, has ready for distribution catalogue No. 22, entitled "Something Electrical for Everybody." This catalogue gives net prices, and will be sent on request.

THE BOSTON GEAR WORKS, Norfolk Downs, Mass., has published a very complete catalogue devoted to standard gears. This includes chains, sprockets, bearings, steering devices, etc. This catalogue will be sent to any one interested upon request.

THE SARCO FUEL SAVING AND ENGINEERING COMPANY, West Street Building, New York city, has ready for distribution considerable literature devoted to the Sarco CO_2 recorder and the Caldwell automatic mechanical coal shovel. The Sarco recorder is well known under the old name of "Ados."

FAHN & McJUNKIN, 201 East Sixteenth street, New York city, has purchased the interests of the Thomas D. Carpenter Company in the manufacture of pumps for exhausting incandescent lamp bulbs. The business of the latter company will hereafter be carried on by Fahn & McJunkin at the above address. Fahn & McJunkin has also made arrangements with the Linolite Company of America to establish a factory at 201 East Sixteenth street, where the Linolite Company's products will be under its supervision. The company is now working on the equipment for four large lamp factories, and reports a very brisk business condition.

THE SPRAGUE ELECTRIC COMPANY, New York city, in its new bulletin "Electric Power in the Printing and Allied Trades," have traced the remarkable progress made by it in equipping different kinds of printing machinery with Sprague motors. The list of printing establishments given as having been supplied, covers a great number of concerns in domestic and foreign countries. This bulletin, No. 229, contains seventy-four pages eight by ten and one-half inches and is filled with information and suggestions invaluable to the progressive printer and those having to do with binding, electrotyping and stereotyping machinery.

OBITUARY NOTES.

MR. DAVID E. EVANS, president of the Maryland Telephone Company, died in Baltimore, Md., on August 15, from peritonitis. He was born in Wales fifty-seven years ago. Mr. Evans was prominent as a consulting electrical engineer and as a builder of railways. While a young man in Wales he won the praise of Queen Victoria for his heroic rescue of a party of miners.

MR. L. L. DAVIS, proprietor of the Davis Electric Manufacturing Company, died at Laconia, N. H., August 13. He had been ill for two years with a complication of diseases. Mr. Davis, who was sixty years old, was formerly a resident of Springfield, Mass., for about thirty years. He was also the proprietor of the Davis Level and Tool Company. Mr. Davis is survived by one daughter. He was buried at Laconia on August 15.

MR. HOMER PARMELEE died at the home of his brother, Justin, 1056 West Monroe street, Chicago, Ill., on Monday, August 12. Mr. Parmelee was born at Middlebury, Vt., December 31, 1818. He was a pattern-maker by trade, and was employed for many years by Bartlett, Haywood & Company, of Baltimore. He was a man of great genius in invention and many of his devices are now in use. About nine years ago he invented the pipe wrench that bears his name, and which has found a large demand in the hardware trade.

DATES AHEAD.

Jamestown Tercentennial Exposition. Norfolk, Va., April 26 to November 30.

Canadian Electrical Exhibition. Montreal, Quebec, September 2-14.

Canadian Electrical Association. Annual convention, Montreal, Quebec, September 11-13.

Old Time Telegraphers' and Historical Association and Society of the United States Military Telegraph Corps. Annual meeting. Niagara Falls, N. Y., September 16-18.

Vermont Electrical Association. St. Albans, Vt., September 18-19.

Colorado Light, Power and Railway Association. Annual convention, Denver, Col., September 18-20.

Railway Signal Association. Annual meeting, Milwaukee, Wis., October 8-10.

American Electrochemical Society. Fall meeting, New York city, October 10-12.

American Street and Interurban Railway Association. Atlantic City, N. J., October 14-18.

Record of Electrical Patents.

Week of August 13.

862,871. PROCESS OF REDUCING METALLIC SULFIDS. Edward L. Anderson, St. Louis, Mo., assignor of one-fourth to Thomas B. Harvey, St. Louis, Mo. An electrolytic method.

862,891. TROLLEY-POLE SUPPORT. Hugh W. Fellows, Cahuenga, and Ira A. Cammett, Hollywood, Cal. A pivotally-supported, spring-controlled pole.

862,916. ELECTRICITY MOTOR-METER. George Hookman, Birmingham, England. The magnet poles are submerged in mercury.

862,935. APPARATUS FOR WINDING INDUCTION-COILS. Carl A. Pfanstiehl, Highland Park, Ill., assignor, by direct and mesne assignments, to Pfanstiehl Electrical Laboratory, North Chicago, Ill. An apparatus for insulating induction coils.

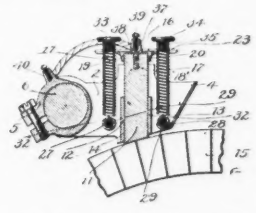
862,938. METHOD OF MAKING COMPLETE FUSE-STRIPS OF SAFETY-FUSES. Frank D. Reynolds, Hartford, Ct., assignor to The Sachs Company, Hartford, Ct. A holder for adjusting fuses.

862,951. BRUSH-HOLDER. William L. Waters, Milwaukee, Wis., assignor to National Brake and Electric Company, Milwaukee, Wis. The brush is held by parallel springs.

862,965. INCANDESCENT-LAMP SHADE. Henry D'Olier, Jr., Philadelphia, Pa. A metal reflector.

862,996. PROCESS OF REDUCING COMPOUNDS AND PRODUCING LOW-CARBON FERRO ALLOYS. Edgar F. Price, Niagara Falls, N. Y. A molten reducing agent is percolated through the change in an electric furnace.

863,008. ELECTRICAL MEASURING INSTRUMENT. William E. Sumpner, Birmingham, England. The moving element is in a magnetic field, the rate of change of which is proportional to the voltage of the supply.



862,951.—BRUSH-HOLDER.

863,109. INDICATOR FOR ELECTRICAL MEASURING INSTRUMENTS. Frederick G. Simpson and William M. Price, Seattle, Wash. A device for indicating an excessive current in the instrument.

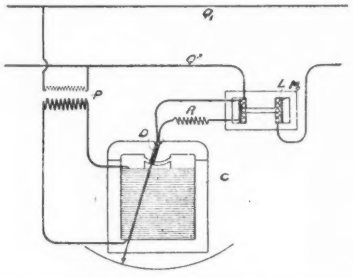
863,152. HOIST. John H. Clark, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York. The generating unit is smaller than the motor, so that stalling the latter will not damage it.

863,163. PROTECTIVE DEVICE FOR SERIES TRANSFORMERS. Charles E. Eveleth, Schenectady, N. Y., assignor to General Electric Company. Automatic means are provided for preventing an abnormal decrease in the current.

863,165. CIRCUIT-CONTROL APPARATUS. Richard Fleming, Lynn, Mass., assignor to General Electric Company. The time of contact of a floating member is controlled by changing the position of the stationary members.

863,175. INDUCTION-COIL. John O. Heinze, Jr., Lowell, Mass. A means of winding pancake coils.

863,177. AUTOMATIC TRIPPING SAFETY DEVICE FOR ELECTRIC MOTORS. Augustus Herath and Iver Hultman, Schenectady, N. Y. The motor is thrown out of gear if the air-gap becomes dangerously small.



863,008.—Electrical Measuring Instrument.

863,178. LAMP-SHADE. Walter O. Holt and Ralph L. Foster, Providence, R. I., assignors to Livermore & Knight Company, Providence R. I. A form of shade.

863,185. PROTECTIVE DEVICE FOR ELECTRIC CIRCUITS. Thomas I. Jeffries, Pittsfield, Mass., assignor to Stanley Electric Manufacturing Company, Pittsfield, Mass. Two independently movable members responsive to different overload currents are employed.

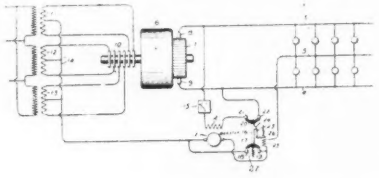
863,188. MOTOR CONTROL. Charles B. Larzelere, Schenectady, N. Y., assignor to General Electric Company. A series parallel controller.

863,201. MEANS FOR PROTECTING DYNAMOELECTRIC MACHINES. Charles T. Mosman, Schenectady, N. Y. Current is diverted from the motor armature if overloaded.

863,224. ELECTRIC METER. George A. Swain, Swampscott, Mass., assignor to General Electric Company. A meter case.

863,225. PREPAYMENT MECHANISM. Ernest Schattner, Schenectady, N. Y., assignor to General Electric Company. A prepayment meter.

863,230. TELEPHONE REPEATER-CIRCUIT. Herbert E. Shreeve, Newton, Mass., assignor to American Telephone and Telegraph Company. The energy generated in the repeating apparatus is prevented from reacting upon the receiving element.



863,201.—Means for Protecting Dynamoelectric Machines.

863,238. INDICATION APPARATUS FOR SWITCH AND LOCK MOVEMENTS. Louis H. Thullen, Edgewood Park, Pa., assignor to The Union Switch and Signal Company, Swissvale, Pa. An electrical indicator for track switches.

863,247. METHOD OF AND APPARATUS FOR TRANSMITTING ELECTRICAL ENERGY. Walter C. Yeatman, Chicago, Ill., assignor to American Telephone and Telegraph Company. An alternating current of high frequency is impressed upon a conductor consisting of a central core surrounded by a thin, continuous sheath of magnetic material.

863,253. TELEPHONE-RECEIVER. William R. Bankhead, Bremerton, Wash. A horse-shoe magnet with legs of an equal length is used.

863,293. ELECTRIC RESISTANCE DEVICE. Harry W. Leonard, Bronxville, N. Y. The resistance is embedded within an infusible material.

863,296. ELECTROMAGNET. David L. Lindquist, Yonkers, N. Y. An alternating-current magnet.

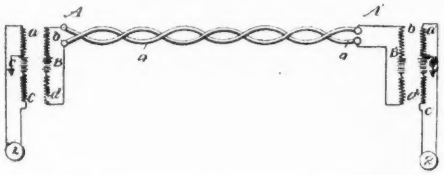
863,320. MEANS FOR SECURING AN ELECTRIC-LAMP RECEPTACLE TO A SUPPORT. Robert P. Schriver, Philadelphia, Pa. A flanged receptacle.

863,332. ELECTROMAGNET APPARATUS FOR RAILWAY PURPOSES. Louis H. Thullen, Edgewood Park, Pa., assignor to The Union Switch and Signal Company, Swissvale, Pa. A device for indicating the approach, departure or presence of a train on a track section.

863,335. SLOW-SPEED CIRCUIT-CONTROLLER. Herbert A. Wallace, New York, N. Y., assignor to The Union Switch and Signal Company, Swissvale, Pa. Employs two discs rotating about a common centre.

863,338. TELEPHONE TRUNK-CIRCUIT. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A trunk circuit for a central energy system.

863,339. ELECTRIC SELF-WINDING CLOCK. Aloys Wirsching, Brooklyn, N. Y. A reciprocating winding device.



863,247.—Method of and Apparatus for Transmitting Electrical Energy.

863,410. DYNAMO CONSTRUCTION. Henry Leitner, Maybury, Woking, England. Fixed subsidiary brushes connected with the winding of the field magnets are located so as to maintain a constant potential irrespective of the speed.

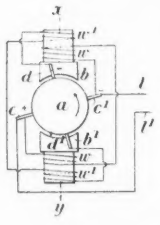
863,452. SAFETY SIGNAL DEVICE. Malcolm Salmond, Baltimore, Md. An electrical signal system for railway torpedoes.

863,454. ELECTRIC HEATING ELEMENT. George J. Schneider, Detroit, Mich., assignor to American Electrical Heater Company, Detroit, Mich. A unit built up of alternated laminated conductors and insulators.

863,455. ELECTRIC SAD-IRON. George J. Schneider, Detroit, Mich., assignor to American Electrical Heater Company, Detroit, Mich. The heating unit is enclosed within a recess in the iron.

863,509. ELECTRIC RAILWAY SIGNALING SYSTEM. Charles M. Cleavland, Wausau, Wis., assignor of one-fourth to Hiram Dunfield, Wausau, Wis. A block signal system employing a pair of bare conductors parallel with the track.

863,540. TRAIN-CONTROLLING APPARATUS. Joseph L. Jones, Kizer, Tenn. A wireless system of train control.



863,410.—Dynamo Construction.

863,556. MOTOR-DRIVEN AIR-COMPRESSOR. Edward D. Priest and Einar J. Bring, Schenectady, N. Y., assignors to General Electric Company. A special arrangement of motor and compressor.

863,568. ELECTRIC-ARC LAMP. Reinhold T. Felsch, Boston, Mass. An automatic regulating device consisting of a solenoid responsive to the lamp current.

863,569. SIGNAL MECHANISM. Ellsworth E. Flora, Chicago, Ill., assignor to The Zorge Safety Railway Equipment Company, Chicago, Ill. An electrical track signal device.

863,570. ELECTRIC TIME-ALARM. Jacob L. Grass, Walter, K. Cook, Charles W. Fletcher and Frederich J. Arndt, Minneapolis, Minn., assignors to American Bank Protection Co., Minneapolis, Minn. The alarm is automatically checked after having been sounded.